CURRENT SCIENCE

Vol. XIV] AUGUST 1945 [No. 8

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ATOMIC ENERGY

THE announcement from Washington on August 6, of the production of atomic bombs more powerful than 20,000 tons of T.N.T. and possessing blast power over 2,000 times that of the British 22,000 pounder, has taken the world by surprise. It appears that the Japanese town of Hiroshima on which it was first dropped is almost completely destroyed. The reactions that followed the above announcement can be briefly summarised. First, there was excitement that under the stress of war the process of releasing atomic (nuclear) energies on a large scale has reached a stage of perfection though for the time being for destructive purposes. Then there was a feeling of confidence that the Japanese War would come to an end sooner than expected. This has since been found to be justified. Finally, every human being capable of comprehension was shocked to hear about the devastating effect on civilization of this new and revolutionary weapon of destruction. This sense of horror was followed by a prayer that "these awful agencies will be made to conduce to peace among nations and that instead of wrecking measureless havoc upon the entire globe, they may become a fountain of world prosperity".

The idea that the core of the atom is a store-house of energy is not of recent origin. The study of the subject started with the discovery by Becquerel towards the end of the last century, of a phenomenon exhibited by uranium, the heaviest of all the known elements. This property which is now known as radio-activity is the spontaneous disintegration or splitting up of atoms with the emission of charged particles. Subsequent experiments revealed the existence of a number of radio-active substances, all of them derived from one of the two parent substances, namely uranium and thorium, which were continuously radiating and producing each a new element. Radium is one such transformation product emitting very penetrating radiations which have been used for treatment of cancer, etc. During these transformations, though small in number, energies of the order of a few million electron volts are released. (One electron-volt energy corresponds to about 10^{-12} of an erg.) In a gram of uranium about 24,000 atoms break up per second with the emission of alpha particles. (An alpha particle is a doubly ionised helium atom.) Yet the number of atoms in a gram is so great that it would take about 4,500 million years before half the atoms are transformed. As it was not possible to influence these spontaneous disintegrations of atoms by any physical processes, we could not accelerate the production of energy by this means.

Further investigations on this subject by Lord Rutherford and his school gave us some idea about the structure of atoms. It is now known that the atoms of all elements have a similar type of structure. The atom consists of a positively charged nucleus carrying most of its mass. The nuclear charge which is also called the atomic number, has a value 1 for hydrogen and 92 for uranium. The nucleus is surrounded by a cloud of negatively charged particles called electrons whose number and distribution as well as the chemical properties of the element as a whole are controlled by the nuclear charge. Elements having the same nuclear charge or atomic number but different masses are called isotopes. It is now a well-established fact that the majority of the elements consist of a mixture of isotopes.

In the ordinary chemical processes in which only the outer electrons take part, the energy released is of the order of a few electron-volts per atom; this is only about a millionth part of the energy released during nuclear transformations. It is easy to imagine the stupendous rise in energy that could be effected by carrying out nuclear transformations on a very large scale.

In 1919 Lord Rutherford showed that the nitrogen nucleus was transformed when the

latter was bombarded by the powerful projectiles of alpha particles from radioactive sources. In the succeeding years it was established that a number of light elements could also be transformed in a similar way. As a result of a close study of these artificial transformations, the existence of a new type of particle of great importance called the neutron was discovered in 1932. These are formed when the element beryllium of mass 9 is bombarded by alpha particles from radium. As the neutron is electrically a neutral particle having a mass nearly equal to that of a hydrogen nucleus, i.e., a proton, it can penetrate the electrical barrier of the nucleus with but little opposition. Fermi was the first to realise that the neutron was a most promising agent for effecting nuclear transformations especially in the heavy elements.

Soon after the discovery of artificial radioactivity by Curie and Joliot in 1933, Fermi observed that radioactivity could be induced in many elements by neutron bombardment. By bombarding uranium and thorium with neutrons, Fermi and his associates obtained a series of new radioactive bodies emitting negative electrons, and from their chemical behaviour they were led to believe that these activities belonged to elements having atomic numbers greater than 92. These new elements were called trans-uranic elements. Hahn, Meitner and Strassman extended these investigations. They definitely established in January 1939 that isotopes of barium of atomic number 56 and of lanthanam 57 were formed as a consequence of the bombardment of uranium and thorium with neutrons. Similar results were obtained by Curie and Savitch almost simultaneously. These results suggested that after neutron capture the uranium or thorium nucleus splits up into two nuclei of medium atomic weight giving rise to a new type of disintegration—*nuclear fission*. Meitner and Frisch offered an explanation of the phenomenon of fission on the basis of the Böhr nuclear model. With sufficient energy of excitation, the heavy nucleus breaks up into lighter nuclei, just as a liquid drop will split up into smaller drops if enough energy is given to it. It has been shown that after splitting, the fission products will gain a total kinetic energy of the order of 200 million electron-volts. The energy released during fission is, therefore, more than twenty times the energy released in the ordinary nuclear transformations. Numerous investigations carried out in various laboratories have established that fission can be induced in uranium, thorium and protactinium not only with neutrons but also with high-energy charged particles such as deuterons, protons and alpha particles.

At the instant of fission the products are formed in a very highly excited state and consequently direct liberation of neutrons will take place. This was experimentally confirmed by Joliot, Halban and Kowarski. They showed that several secondary neutrons are emitted during each fission of the uranium nucleus. These are of a different type, i.e., they are fast or high-energy neutrons. Thus a single neutron causing a rupture of the nucleus not only liberates vast quantities of energy, but also produces additional neutrons which can in turn cause further fission, thus releasing more and more energy. A great deal of interest is attached to this discovery as it leads to the possibility of a cumulative process of exothermic disintegration or chain reaction releasing terrific amounts of energy in a very short time and ending in a catastrophic explosion. This aspect of the problem which was only of theoretical interest in the year 1941, appears to have been fully worked out, resulting in the manufacture of the atomic bomb.

The necessary condition for the progress of the chain reaction is that at every stage the average number of secondary neutrons produced per fission should always be greater than the number that would be lost by capture processes which do not result in fission. This has been achieved by using fairly large quantities of a suitable compound of uranium isotope of mass 235 as the main constituent of the bomb and thermal neutrons as exciter of fission. Uranium has two isotopes, one of atomic weight 235, the other of 238. Nier, Booth, Dunning and Grosse who investigated nuclear fission in separated isotopes of uranium, showed that the yield of slow-neutron-induced fission in the lighter isotope is many times greater than in the heavier isotope. The lighter isotope is only a small fraction of the natural uranium which itself is a rare element. The practical problem is, therefore, to concentrate large quantities of the uranium of mass 235. This has been accomplished at a cost of a few hundred million sterling. Of the well-known methods of separation of isotopes, either the thermal diffusion method or the mass spectrographic method might have been developed successfully for the production of uranium 235 on a large scale.

As has already been remarked, the secondary neutrons emitted during the process of fission are of very high energy and in order to produce the chain reaction, it is necessary to introduce some hydrogen-containing substance to slow the secondary ones. Heavy water appears to have been used for this purpose. This refinement in technique has the additional advantage that during the process of slowing the high energy neutrons by collision with the heavy hydrogen or deuterium nuclei, more neutrons will be emitted as a result of the dissociation of the latter.

When once a large quantity of the atomic dynamite is available, it is comparatively easy to devise a trigger mechanism by which a beam of neutrons could be released suddenly at the right time for exploding the dynamite. It is of the utmost importance to see that the stray neutrons which are to be found everywhere due to cosmic radiation do not prematurely blow up the bomb. The use of a large quantity of silver in the manufacture of the atomic bombs has been reported. It is not unlikely that the silver may have been formed into containers for the explosive material, to absorb any stray neutrons of cosmic-ray origin.

It is estimated that one cubic metre of uranium oxide is capable of developing 10^{12}

kilowatt-hours of power in less than 0·01 sec. The sudden release of such a tremendous energy gives rise to a blinding flash many times brighter than the mid-day sun, which is followed by a tremendous and sustained roar and a heavy pressure wave. This causes destruction to men and material on a scale hitherto unknown. Because of this fact, the discovery of the atomic bomb has made warfare terrific beyond imagination. It is therefore imperative that in future the production of this new type of weapon should be effectively controlled in the interests of the whole world and not of one nation or another. It is to be hoped that in the mean time no efforts will be spared by the nations who are in the know of the secrets of the atomic bombs towards finding a suitable antidote for the same.

If the tremendous energy released from atomic explosions is made available to drive machinery, etc., it will bring about an industrial revolution of a far-reaching character. It is estimated that a pound of uranium can generate the same amount of power as a few million pounds of coal. But there are obvious difficulties connected with the control of the evolution of atomic energy. It is easier to make a destructive bomb on the atomic principle than it is to harness atomic power for peace-time purposes, and a great deal more research work is needed before atomic power can be put to industrial use. It is necessary to emphasize that the prospects of producing cheap atomic power are none too bright, however, if the chain reaction can be propagated only by slow neutrons acting on the less abundant isotope of uranium. It is to be hoped that practical ways may be found for utilising the transmutations of the commoner elements for the production of power.

R. S. KRISHNAN.

IMPERIAL CHEMICAL INDUSTRIES (INDIA) RESEARCH FELLOWSHIPS

AT the Ordinary General Meeting of the National Institute of Sciences of India held at Calcutta on the 23rd July 1945, Mr. D. N. Wadia, President, announced that he had received a letter from Lord McGowan, Chairman of the Imperial Chemical Industries, forwarding a document offering to the National Institute a sum of Rs. 3,36,000 for creating Research Fellowships in Chemistry, Physics and Biology at the Indian Universities or institutions approved by the Council of the National Institute, for over a period of five to seven years. The reasons and hopes which had prompted the Imperial Chemical Industries to offer a number of Research Fellowships to the Institute were explained by Lord McGowan in the following words:—

"The National Institute of Sciences is, we believe, destined to play in India a part similar to that which the Royal Society of London has performed for nearly three hundred years in leading the scientific progress of this country.

"The Royal Society until recent years was hampered by lack of funds and provision for the maintenance of scientific workers. This difficulty was eventually overcome by the generosity of various benefactors, including Industrialists such as Mond and Messel.

"We thought, therefore, that there could be no better way of encouraging the advance of science in India and with it the general prosperity of the country than by the offer of these Fellowships which under the wise administration of your Council will, we hope, lead to an augmentation of the distinguished successes in science already attained by so many of your fellow countrymen."

The following are the terms under which the fellowships are to be created:—

1. Each fellowship to be worth Rs. 400 per month and to be tenable in the first instance for two years, with a possibility of extension up to a total of three years. (It is assumed that half the fellowships will be extended for a third year.)

2. In addition there will be a grant for research expenses to be made to the fellowship holders according to their needs of special apparatus and materials. For this purpose the National Institute will have at their disposal an average of Rs. 600 per annum for each fellowship.

3. There will be a grant of Rs. 13,200 per year to the National Institute for five years to enable them to pay for administration and the travelling expenses of such fellows of the Institute as may be selected to visit the fellowship holders at their Universities or Institutions.

The National Institute of Sciences is asked to administer the funds for the fellowships on the following principles:—

1. Appointment to and control of the fellowships to be made by the Council of the National Institute, acting on the advice of a special research fellowships committee.

2. This Special Research Fellowship Committee will represent various scientific fields and be drawn from various parts of India, so as to include any community, the over-riding consideration for membership being scientific fitness therefor.

3. The fellowships will be open to persons, irrespective of sex, race or religion, resident or domiciled in India (British India or the States) and under 35 years of age.

4. The fellowships will be tenable at any University or Institution in India, approved by the Council of the National Institute.

5. Fellows will be permitted to do a little amount of approved teaching or demonstrating. This should not be more than six hours per week and it should be a condition that they are paid for this work by the Institution or University at its normal rates.

6. The aim of the fellowships is to strengthen research in Indian Universities and Institutions, and it is hoped that the National Institute of Sciences will spread the research fellowships over them in accordance with this aim, but with the over-riding consideration of the scientific suitability of the particular University or Institution.

ONE IN ALL: ALL IN ONE

By J. J. ASANA

(Gujarat College, Ahmedabad)

Religion, the Supreme Need of Our Scientific Age

ONE may feel considerable trepidition in placing before the scientific minded readers of *Current Science* the following speculations but for an equally strong feeling that they may perhaps serve a useful purpose.

This catastrophic war has taught us once again in a very striking manner how irrational and inhuman we are despite our boasted advance in scientific thought and in the application of the findings of science to the affairs of human society. Why is it so? In the analysis of the problem many causes and for its solution many remedies are being suggested. Among various measures proposed for the removal of this most distressing state of things is the reorganisation of all social and political activities on scientific lines. Industries, educational system, social and political relations of mankind, it is being urged, should be recast and remoulded in accordance with scientific methods of enquiry into problems. It seems highly probable that in the world of tomorrow workers in science will be called upon to shoulder heavier responsibilities as citizens than they have borne hitherto not only in the planning and reconstruction of industries and material environment of man but in matters pertaining to human, social relations also.

That the application of scientific methods of enquiry to industrial, economic and social problems will prove fruitful, as it has turned out so profitable in the investigation of natural phenomena, one feels little doubt. That the cold, calculating, dispassionate gaze of science may be relied upon to illuminate the entire range of all the environmental conditions amidst which mankind is living to-day appears to be a sound proposition and likely to yield results of value. But one feels that if we disregard or continue to look upon with more or less indifference, as we have been doing hitherto, all those matters, considerations, human attitudes, which generally go under the headings, 'religion' and 'morality', our scientific endeavours to remedy the existing evils and put things straight may not come up to the expectations that people entertain regarding science as one of the most potent instruments in the fight against evil and for the increase of human welfare.

Obviously one cannot adduce scientific evidence in support of the above-mentioned statement that science is likely to fall short of its expectations. For one thing 'religion', 'morality', 'things of the spirit' are words and expressions lacking in the type of definition and precision of meaning with which students of science are familiar. But since the advent of our scientific age, and as some thoughtful people believe partly because of it, events have happened in human societies, which should give sufficient reason to us, men and women trained in the methods of science, to examine anew our conceptions of religion and morality and all that they signify in the affairs of man.

The agnostic, non-committal attitude of the generality of men of science of the past and the present towards the questions is well known and easily understandable on intellectual grounds. It was and it is to a degree justifiable in view of their avowed profession. But it is conceivable that they may have blundered consciously or unconsciously in extending this agnostic, noncommittal attitude of 'scientific materialism' of the laboratory to the outside, to their philosophy of life and in the world affairs. And it is also conceivable that in view of the increasing prestige of science in the last one or two generations, the repercussions of this indifferent mental attitude towards discussions of religion and morality in the world outside might have been greater than men of science imagine. This attitude, being easier to understand and maintain, might have almost imperceptibly permeated to a considerable extent the minds of the non-scientific intelligentsia all the world over. We are perhaps too near the events to assess rightly to what extent for good or evil, this negative, indifferent attitude towards religion and morality influenced the economic, political and social relations of men during recent times. But there is a considerable body of thoughtful men, including a few professional scientists, who have been saying for the past several years that this indifferent attitude, engendered and fostered by scientific materialism as its philosophy, is not so tenable as it was supposed. And there may be some truth in the indictment that though science indirectly helped to destroy effectively many superstitions and harmful practices going as religion and morality, it may have come in the way of spreading righteousness and goodwill among men by maintaining an indifferent attitude towards religion and thus lessening its emotional drive and influence for the good of mankind fostered by feelings of sacredness and righteousness.

An Idea of God

Recent investigations by several eminent men of science in Physics, Chemistry and Biology have thrown a new light on our conceptions of matter, space and time. Readers of this Journal are all familiar with these remarkable researches taking place on the frontiers of these branches of natural science, bringing their far-flung boundaries closer to one another every day. They all point to a great generalization, which is slowly emerging. That behind this external separateness, at the back of this variety and diversity of phenomena that men of science are studying there lies a basic, fundamental unity, admittedly difficult to conceive and define. Some of these fundamental researches of men of science are highly suggestive. They warrant a justifiable inference that the different phenomena that the biologists, chemists and physicists are investigating in their respective fields may really

be materialized expressions, outward manifestations of some fundamentally unique, still mysterious agency, difficult to grasp intellectually, difficult to put into words and to be communicated, but perhaps lying within the ambit of individual human experience.

One of the basic sciences, a more or less exact science such as Physics, postulates, as we all know, on grounds which are sound and scientific an underlying '*relation*' a sort of '*connection*' between the 'observed' and the 'observer', between the phenomenon and its investigator. It is true that the exact nature of this relation at present eludes us. But bearing in mind these scientific considerations would it be too big a jump, even on intellectual grounds, shall we be accused of forsaking reason, if we infer that the observed and the observer, the experienced and the experiencer are so-called material expressions, the manifestations of some agency, fundamentally unique, whose creations they are?

This 'One' in all may conceivably serve us as our conception of God, even as a hypothesis to be experienced and realized, God in Whom the ideas 'I' and '*not-I*' or '*the other*', the idea of '*self*' and '*not self*' lose their separateness and distinction and merge into 'One'.

If our fellow-workers in science, at least in India, can feel no intellectual compunction to subscribe to such ideas, they will only be paying well-merited homage to those great thinkers of our ancient land whose magnificent efforts had almost reached the farthest limits of human intellect and will.

Mind, Spirit, Soul

That these terms and the conceptions they engender lack definition and precision of scientific terminology and thought is a matter of common knowledge. How inadequately they have been defined and explained in other words in standard dictionaries can be easily ascertained. And yet it is equally well known what an important part human activities associated with these words have played in the career of man on this planet. Students of science of course know this. But as regards the existence and nature of mind are not our views coloured by scientific materialism? If one mistakes not, orthodox science believes that mind can only exist in association with animal body, being an integrated function of a system of organs, the nervous system. Science is not prepared to give any countenance to the statement that mind activities normally associated with a living human body may be manifested otherwise.

But in view of some experimental work which is being carried out on truly scientific lines of telepathy and clairvoyance, under the general name Extra Sensory Perception (E.S.P.), and on telekinesis, etc., at Duke University, North Carolina, U.S.A., by J. B. Rhine and his associates[1] and also in Great Britain[2] we may have to revise some of our ideas regarding mind. This kind of work on scientific lines lends support to some of the most remarkable findings recorded in the *Proceedings of the Society for Psychical Research* (*London*), and to the pronouncements and opinions of eminent philosophers and writers like Professor B. L. Atreya[3] and Professor C. L. Reiser[4], and Pandit D. V. Gundappa[5]. In this connection it is also interesting to quote the great historian of science, Charles Singer[6]. At the end of the last paragraph concluding his book, he says: "Notably it seems probable that the conceptions of the separation of mind from mind and of mind from matter may need modification. There are many indications that the tendencies of science since the later nineteenth century have been working in these directions."

Religion as the Basis of Morality

Attempts are being made to define moral and immoral acts and find justification and sanction for morality on intellectual grounds and on the findings of science. That it is difficult to divorce morality from intellect and reason, which science constantly uses, will be granted at once. Few will dispute that knowledge is necessary to calculate and weigh the consequences of our acts and to arrive at judgments. As scientific knowledge of the conditions amidst which men behave is reliable, science can help in this direction.

But is it all a matter of knowledge, of scientific knowledge? Do people always act in the way of what they call morality by weighing the consequences of their acts? What of the behaviour of large masses of people, for instance in England and Russia, in times of crisis, which change the course of history, such as the present war? May we ask, whether material considerations alone sustained some of these people in their darkest hour and made them put forth their mightiest effort when unheard of destruction, total defeat and disaster were staring them in the face. It is probable that many of them, if not all, *felt* that a certain course of action on the part of a nation, as in the case of an individual was *implicitly* unrighteous and immoral, and they reacted. It is conceivable that reason and weighing of consequences alone could not have driven many of them to make the supreme sacrifice. The righteous resolve may have been engendered by *feeling* and sustained by *faith*. They felt and experienced certain values. It seems then that feeling and faith may yet be counting a great deal in the affairs of morality.

But it may be asked where comes in religion here, which has been such a fruitful source of misunderstanding and disharmony among men. Could not all that has been said above go under 'Scientific Humanism'?

One feels that a good reason may be given for putting the new wine—the scientific understanding of man, nature and God—in the old bottle, religion. Common people, educated, but not well versed in the way science tackles problems, will feel heartened when they are told that in matters of morality, which are intimately connected with religion as it is understood by ordinary people, science is not in a position to put *feelings* and *faith* out of court altogether. The statement that intellectual considerations alone do not induce men to perform moral acts will strengthen the faith of the common men in many of the sayings of the great prophets and seers with which science can have no quarrel.

And we, students of science, on our part lose nothing; we shall not be committing any intellectual 'Harakari' if we grant the hypothesis that those great prophets and seers had seen farther in their own way in these matters of religion and morality. As regards their conception of God it is conceivable that they may have felt more intensely the presence of some unique agency, the unity underlying the diversity of phenomena, that men of science are unravelling to-day. They have proclaimed in no uncertain terms that man can aspire to realize 'One' in all. They saw the same face in the myriads of faces animate and inanimate.

And finally, it may be that the great justification of science, the true philosophy, is yet to come. The present-day scientist, the devotee of the external, soul bewildering frills and frescoes of the outer temple may some day find unimaginable peace and harmony by withdrawing in the inner temple of the soul where all is one, heartily subscribing to the truth and utility of the profound adage, 'Do unto others as you would have them do to you'.

1. " Address, the Parapsychology Laboratory, College Station, Durham, North Carolina, U.S.A.," *The Journal of Parapsychology*. 2. Soal, S. G., & Goldney, K. M., " Experiments in Precognitive Telepathy," *Proceedings of the Society for Psychical Research*, Parts 1 and 2, December 1943. Review in *Nature*, No. 3880 of 11th March 1944, by E. J. Dingwall. 3. Atreya, B. L., " Supernormal Factors in Human Personality," Presidential Address(Section of Psychology and Educational Science), 30th Indian Science Congress, Calcutta," 1943. 4. Oliver L. Reiser, " Humanism and the World Mind," *The South Atlantic Quarterly*, 1939, **38**, No. 2, April. 5. (*a*) Gundappa, D. V., " Science and Ethics," *Current Science*, December 1941, **10**, No. 12; (*b*) Gundappa, D. V., " Towards a New World Order, An Indian View," An Address delivered to the Joint Easter Session of Science Associations in Bangalore, India, April 1942. 6. *A Short History of Science to the Nineteenth Century*, 1941. (Charles Singer, Publ. Oxford, at the Clarendon Press.)

THE APPLICATION OF INFRA-RED SPECTRA TO CHEMICAL PROBLEMS*

APPLICATIONS of spectroscopy in different directions have been the subject of so many conferences on the subject that Professor Mulliken in opening the conference on spectroscopy in 1942 remarked, "Less attention has been given lately to spectroscopy as a pure science ..... It seems to us that the pure science aspects of spectroscopy deserved new emphasis." In the case of infra-red spectroscopy, however, difficulties confronting the investigator have been such that the number of votaries have been relatively small and the report under review represents one of the few conferences that have been specially devoted to this part of the subject. The collection of papers here constitutes a welcome report of the present position of the subject, though it represents essentially the contributions of the British school of workers from Oxford and Cambridge, an isolation presumably due to the difficulties of war time.

As one peruses the different papers, Professor Rideal's introductory remark, "It is one of the difficulties inherent in war-time that the Secrecy Act intervenes with different degrees of rigour in the various nations. Here, in this country much work in the field of infra-red spectroscopy has still to be withheld from publication. Our Trans-Atlantic cousins are more fortunate in this respect" constantly occurs to one's mind and it is to be hoped that the Faraday Society will soon have a fuller discussion on the subject.

The report falls naturally into two divisions, the first part dealing with experimental technique and the second with applications to different chemical problems. A brief review by Drs. Sutherland and Thompson on recent developments and present position of spectrometers, optical systems, calibration, detection and recording of infra-red spectra begins the series. This is followed by a useful note on sources of radiation and the preparation of absorption cells and another on accurate measurement of cell thickness. The very brief contribution on solvents gives no doubt valuable information but one cannot help commenting on its laconic character. The time-saving device described by Willis and Philpotts for making hand-operated spectrometers automatic and Dr. Conn's Thermocouple Bolometer detector fill an important need and the increased speed for a given sensitivity should remove one of the disadvantages of infra-red and lead to a larger volume of work.

The greater part of the discussion is devoted to the second section referred to earlier. The value of infra-red spectra lies in the principle that except optical isomers, no two molecules can have an identical array of frequencies and the improved techniques have made it speedier. The principal obstacles in the way have been the difficulties in detecting, recording and computing accurately. An introductory note discussing these is followed by examples of typical analyses of closely related organic compounds, usually of common occurrence, and the report presented bears out clearly the advantanges of this tool.

A critical analysis of available experimental evidence leads Dr. Simpson to a new assignment of the fundamental frequencies of the ozone molecule. While due note is taken in making the assignments of the contour relationships, intensities, and probable values of the force constants, both the paper and the discussion thereon point to the necessity of reinvestigation of both electron diffraction and infra-red results. The paucity of the Raman

* *Transactions of the Faraday Society*, 1945, **41**, 171–297. Report of a discussion held on 2nd January 1945. Price 15*s*. (Messrs. Gurney & Jackoon, London.)

spectra studies is quite noticeable, the only reported investigation being that of Sutherland and work on this also should lead to more valuable data for a correct assignment of frequencies. Still, the essential features of the structure of the ozone molecule may not be altered. In deciding on the possible contributing structures, however, the magnetic susceptibility value cannot rule out structures II and VI (p. 210), the observed feeble diamagnetism being of the right order of magnitude if these structures are also taken into account.

Of considerable interest to the chemist is information concerning the carbon-carbon bond and the bonds between hydrogen and the elements of the first short period. Bartholomè and Teller have shown that C-C vibrations lie between 809 and 1143 cm.$^{-1}$ but this region sometimes involves overlapping with the C-H bending vibrations. Using Teller's method for a system of mass points in one plane, Kellner has found a remarkable agreement between his calculated and observed values of frequencies for open chain and alicyclic hydrocarbons as well as for various degrees of branching in the chains. There are, however, a number of instances where the frequencies given as "observed" by Kellner differ from those values reported by other authors and these other values bring out discrepancies. This only shows the limitations of any oversimplified method of approach as is the case here but the approach is none the less useful.

Linnett's evaluation of the force constants leads to a number of interesting results with the C-H bond. Abnormal values are obtained in the case of saturated hydrocarbons of the aliphatic series and their derivatives, whenever a resonance hybrid structure involving ionic structures is possible, as, for example, methyl fluoride and diphenylmethane. The special behaviour of the first member of a homologous series is noticeable here too. The change from these saturated aliphatic structures to olefinic or benzenoid structures leads to an increase in the force constant which becomes still higher for the C-H bond in acetylenes. This leads to the surprising result that the strength of the bonds increases as the proportion of *s*-orbital in the hybrid bond increases. It is well known that the ease of hydrogen replacement by metals increases as one changes from saturated to acetylenic hydrocarbons and both phenomena have apparently the same explanation: that ionic structures with hydrogen positive make appreciable contribution to the hybrid form. As Higgins has pointed out, the same explanation is possible for the higher force constant in nitromethane. The presence of an aldehydic group also alters the force constant appreciably, in this case a decrease which is quite marked. Using the Douglas Clark relation and the value of the force constants calculated, values of bond lengths have been obtained which agree reasonably well with observed values.

The calculations also bring out the periodicity in the M-H link (M being any element of the III to VII groups). The value of the force constant for the bond between hydrogen and a member of the first short period appears to bear a constant ratio to that of a bond between hydrogen and the corresponding member of the second short period. These generalisations obtained by the use of a drastically simplified potential field has to be treated with some reserve, as other factors also influence the force constant and may not be negligible in all cases. The results are, however, quite useful in correlating approximately the different properties of the bonds in question.

Dr. Sutherland has reported the results of a fresh investigation on the infra-red spectrum of the diamond. "Type II" diamonds are found to exhibit the peculiarity that transmission over the whole range of spectrum investigated was poor with a complete blackout in the region 4·5 to 5 μ. "Type I" diamonds which may all be expected to behave alike, however, show very definite differences as may be noticed from the diagram on p. 290. This difference in behaviour among "Type I" diamonds is noticeable also in ultra-violet absorption. Obviously, a division of diamonds into just two classes is not adequate for a proper classification. While the prominent infra-red absorption bands remain to be explained, the mass of experimental evidence on which Raman has based his theory, makes it a better approximation to truth. As Sutherland suggests, more experimental work in the infra-red is needed and existing discrepancies between theory and experiment have to be accounted for.

The last contribution to the discussion is a brief note by Bell in which by taking a reasonable physical picture of the torsional potential energy, an agreement as good as those with planar vibrations is obtained for the bond torsion.

A group of three papers deal with topics of considerable technical interest. They present a useful account of the technique for the investigation of substances with high molecular weights and indicate means for the standardisation as well as for following the course of polymerisation or vulcanisation of rubber. The report on coal and coal extracts is enough to indicate the usefulness of infra-red spectra in the study of different grades of coal.

The collection of papers in this number lives up to the level aimed at in Discussions of the Faraday Society and should find a place in any library, academic or technological.

S. V. Anantakrishnan.

OBITUARY

DR. HEMENDRA KUMAR SEN

BY the death of Hemendra Kumar Sen at the comparatively early age of fifty-six, India has lost one of her foremost men of science whos econtributions to chemistry, both pure and applied, have been many and varied and whose name and fame as a teacher of chemistry had spread throughout the length and breadth of this sub-continent.

Sen was born at Noorpur, district Faridpore, on the 24th of December 1889. His ancestral home was at Baldhara in the Dacca district. He had his early education at Brahmanbaria, where his father, the late Prasannakumar Sen, was a Deputy Inspector of Schools. After passing the Entrance examination in 1904, he came to Calcutta and joined the City College and here he met his life-long friend, Dr. Bimanbehari Dey, now Director of Public Instruction, Madras.

After graduation in 1908, Sen joined the M.A. classes in chemistry at the Presidency College, Calcutta. Here he came under the influence of the late Sir P. C. Ray who, as is well known, had an almost uncanny instinct for detecting latent merit. He took very kindly to the young student and the latter in his turn cherished a life-long warm affection akin almost to filial piety, for his revered *Guru*.

Sen appeared in the M.A. examination in 1910 but by a cruel irony of fate, failed in the practical examination as he could not carry out a complete analysis of type metal in course of a single day! He passed with a First Class in 1911 and secured in the following year the Premchand Roychand Studentship, the highest distinction to which an Indian student can aspire.

During his college days, Sen had a hard and bitter struggle with poverty. He used to maintain himself by giving private lessons and for some time even lived with Sir P. C. Ray in his former residence at the office and factory of the Bengal Chemical and Pharmaceutical Works, Ltd., at 91, Upper Circular Road, adjoining the compound of the present University College of Science. He had only a single change of clothing at the time and he made his books do duty as pillow by night. Sen was never tired of relating that when Sir P. C. Ray came to know that he was finding it difficult to raise the modest sum of rupees thirty-two, the fees for the Premchand Roychand Studentship examination, he paid the sum himself unasked.

In 1912, Sen proceeded to England to join the Imperial College, London, and here he devoted himself wholeheartedly to Organic Chemistry. It may be mentioned in passing that Sen was extraordinarily versatile. He was at home alike in the domains of Organic, Inorganic and Physical Chemistry and also one of the pioneers of Bio-chemical studies in India. His earliest contribution to chemical literature was a paper, jointly with Dey, on the estimation of nitrite nitrogen by the action of hydrazine sulphate (*Zeitsch. Anorg. Chem.*, 1911, 71, 236). While working at the Imperial College under the late Professor Jocelyn Thorpe, he published a paper on the condensation of ketones with phenols (*J.C.S.*, 1914, 105, 339) and another on the formation of heterocyclic compounds from cyanacetamide and hydroxymethylene-ketones (*J.C.S.*, 1915, 107, 1347). The second paper, which formed part of his thesis for the Doctorate in Science of the University of London, contained an elegant method for the synthesis of quinoline derivatives, which has found its way into standard text-books on Organic Chemistry like Meyer-Jacobson. He was using the surname Sen-Gupta at the time.

Sen returned to India in 1915 and in 1916 he joined the Tata Iron and Steel Works at Sakchi where, however, he spent only a few months. Later, he proceeded to Rangoon and worked for some time as the Chief Chemist at the chemical works of Messrs. Jamal Brothers and subsequently at the chemical works of De Souza and Company. At Rangoon he met his future wife Miss Kalpanarani Sen, daughter of the late Mr. N. C. Sen and grand-daughter of the late poet Nabin Chandra Sen, whose name is a household word in Bengal. The marriage was solemnised in 1917 but in 1920, after only three years of a very happy married life, Mrs. Sen died in child-bed.

Life at Rangoon became distasteful after this sad event so that when the late Sir Asutosh Mukherjee offered Sen the newly created chair of Applied Chemistry and called upon him to organise the department, he readily agreed. He joined the University College of Science in 1920 and it was only then that I came to know him though I had met him casually once or twice before his departure for Rangoon.

At the College of Science, where Sen spent sixteen best years of his life, he applied himself to his task with zeal and a singular devotion which stands unparalleled in the history of this Institution. He used to work long hours and often late into the night. No wonder that within a short time he gathered round himself a band of enthusiastic and devoted students, many of whom are now filling responsible positions very creditably.

Sen was by nature impetuous and he had a hearty disregard of red-tape, especially in matters appertaining to his own department. As a consequence, he had occasional clashes about questions of procedure with the University authorities. The latter, however, were always ready to stretch a point in his favour and overlook the irregularities which became less and less frequent as years rolled on.

In the lecture hall also Sen was unconventional, delivering his class lectures scarcely according to the prescribed routine and very often prolonging the period to two or even three hours. But as the lectures were prepared with meticulous care and contained a wealth of information and were enlivened with anecdotes, they seldom failed to interest the most listless of backbench men. It may be said without exaggeration that Sen was easily

the best speaker on scientific subjects of his time.

In 1922 Sen went to Berlin as Sir Rashbehary Ghosh Travelling Fellow and joined the laboratory of Neuberg at the Kaiser Wilhelm Institut at Dahlem and on his return the following year, he turned his attention to biochemical problems, specially those relating to fermentation. He was a firm believer in the possibility of the extermination of the water hyacinth pest by its biochemical utilisation as a source of power alcohol as well as of potash salts and he devoted many years of patient labour to this problem. It is interesting to note that the very first paper in the *Journal of the Indian Chemical Society*, started in 1924, was one by Sen "on the reduction of unsymmetrical dichlor-acetone by yeast".

Problems relating to the generation and maintenance of high temperatures also occupied much of his time throughout the Science College period. In 1927, he was invited by the University of Patna to deliver a course of Sukhraj Rai Readership lectures. The subject he chose was "High temperature flames and their thermodynamics". The lectures were subsequently published in the form of a book which was 'dedicated to the sacred memory of the late Sir Asutosh Mukherjee, the originator of the Post-Graduate system of studies in the University of Calcutta'.

Sen was particularly interested in glass furnaces and experimented with different types of furnaces as well as burners for atomised liquid fuel, as a result of which, a combination was evolved which appeared to be very promising. With a view to give the system a trial on a manufacturing scale, Sen undertook upon himself heavy financial liabilities by starting a glass factory in the outskirts of Calcutta. Unfortunately, it could not be run properly due to various causes, the chief being the want of sufficient working capital. He lost very heavily and the financial worries consequent thereon continued to trouble him all his life and probably hastened the end.

In 1930, he went to Germany for the second time to attend the World Power Conference at Berlin. It was on this occasion that he met Fraulein Fritzi Emich, a daughter of Professor Emich of Graz, Austria. The acquaintance gradually ripened into love. They were married when Sen went to Germany for the third time in 1933.

Attendance at the World Power Conference brought in its train researches on high pressure electrolysis for which elaborate arrangements were made in the workshops of the applied chemistry department. The researches on biochemical problems were also continued with unabated vigour and a new problem—the low temperature carbonisation of Indian coals—was now added to his repertoire. Sen had a firm faith in the efficacy of always having more than one iron in the fire and acted fully upto it.

In 1936 Sen left the College of Science to join his new post as the Director of the Lac Research Institute at Namkum, Ranchi, and remained there for eight years. After the tumult and bustle of Calcutta, Namkum with its absolute quiet, splendid scenery and vast expanse of field and forest gave Sen the rest and repose that he so sorely needed. Under his able guidance, the Lac Institute whose name as a place of active research was practically unknown even to most of the residents of Ranchi itself, lying five miles away, soon became a centre of vigorous research activity, particularly in the domain of plastics.

Namkum also exercised considerable influence on his character and made him more thoughtful, less impetuous and even more lovable if that could be possible. The people of Ranchi idolised him and he was always sure of a warm welcome wherever he went.

Last year he was prevailed upon by the Government of Bihar to accept the post of Director of Industries. Big schemes of post-war reconstruction, for framing some of which Sen was personally responsible, were in the offing and although the strain of the past few years was beginning to tell on his health, he considered it his duty to shoulder the heavy burden. His new duties combined a large volume of routine office-work with frequent tours, and his friends soon perceived alarming signs of rapid deterioration of his health. In October last when Sen was in Calcutta on a short visit, all his friends advised him to apply for leave and take some rest but this he left unheeded. On the 7th of December he came to Calcutta to solemnise the marriage of his son but soon after his arrival, he had a serious breakdown. He had to take to his bed immediately but the best efforts of his friends and relatives were of no avail. He died on the 3rd of June 1945.

The death of Hemendrakumar Sen has left a void in the scientific life of India, which it will be difficult to fill. He was one of the Foundation Members of the Indian Chemical Society, of which he was elected President in 1940. He founded the Indian Institute of Chemistry and was its President on two occasions. He was also one of the Foundation Members of the National Institute of Sciences of India. He served on innumerable committees, both of the Government of India and the local Governments, and his advice was eagerly sought for not only by his brother scientists but also by businessmen and industrialists. In the Indian Science Congress, over the Chemistry Section of which he presided in 1927, Sen was a very popular figure. The discussions in which he took part were always lively while his popular lectures always attracted a full house.

Sen was by nature thoroughly democratic and his intimate friends included many in humbler walks of life. His memory will be long cherished as a treasure by his pupils, relatives and friends.

P. C. MITTER.

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ON THE DESIGN OF EXPERIMENTS FOR WEIGHING AND OTHER TYPES OF MEASUREMENTS

Whilst the theory of the design of experiments as applied to biological investigations in general and agronomic investigations in particular has now reached an advanced stage of development, largely as a result of the work of the Fisherian and the Calcutta schools of statistical workers, the theory as applied to weighing and other types of physical measurements for getting efficient estimates of p given unknowns has only recently begun to be developed. The basic principles of this theory are set forth in a recent paper by Hotelling[1] in which the author has called attention to the need for further mathematical research for obtaining a comprehensive general design. I have been able to obtain such a design in case the number of weighings N is at our choice and have also worked out other general designs for specified values of N and p.

2. Using Hotelling's notation, we may write

$$E(y_\alpha) = \sum_{i=1}^{p} x_{i\alpha} b_i,$$

where $i = 1, 2, \ldots\ldots p$ on the assumption that there is either zero bias in the scale or the bias is known *a priori*, and $\alpha = 1, 2, \ldots\ldots N$. Here $x_{i\alpha} = 1$ or -1 according as the αth weighing includes the ith object in the left or right-hand pan, b_i is the true unknown weight of the ith object, y_α the actual result of the αth weighing and $E(y_\alpha)$ its expectation. For a biassed scale, we may take $i = 0, 1, 2, \ldots\ldots p$, the bias being b_0 and $x_{0\alpha} = 1$.

Assuming that $y_1, y_2, \ldots\ldots y_N$ are uncorrelated and have a common variance σ^2, it follows from the theory of linear estimation as developed by Bose[2] and Rao[3] that the normal equations giving the best linear estimates of the b_i's are

$$X'XB' = X'Y',$$

where X is the matrix $[x_{i\alpha}]$, B the row vector $[b_1 b_2 \ldots b_p]$, Y the stochastic vector $[y_1 y_2 \ldots y_N]$, and X', B' and Y' denote as usual the transpose of X, B and Y respectively.

Let $C = [c_{ij}]$ denote the reciprocal of the matrix X'X so that the variance of the best linear estimate of b_i is $\sigma^2 c_{ii}$. Then the mean variance of the p unknowns for a design is given by

$$V_m = \frac{\sigma^2}{N} \cdot \frac{N \sum_{i=1}^{p} c_{ii}}{p}.$$

If the main object of the experiment is the estimation of the unknowns with the least variance, the most efficient design (for a specified value of N) would be the one for which the *minimum minimorum* of $\frac{\sigma^2}{N}$ is attained for all the p unknowns. The quantity $\frac{p}{N \sum_{i=1}^{p} c_{ii}}$ may, therefore, be defined as the *efficiency* of a given design for providing the estimates of the p unknowns. I have used this quantity for judging the precision of the designs I have obtained.

3. By utilizing the properties of a 2-sided m-fold completely orthogonalized Hyper-Græco-Latin hyper-cube of the *first* order introduced earlier,[4] I have constructed a completely orthogonalized design for $N=2^m$, $p<2^m$ (zero bias) or $p<2^m-1$ (non-zero bias), m being any positive integer, by which each unknown is estimated with the minimum variance $\frac{\sigma^2}{N}$, and thus its efficiency is 100 per cent.

For $N=2^m+1$, $p<2^m$ (zero bias) or $p \leqslant 2^m-1$ (non-zero bias), m being any positive integer, I have obtained two types of designs. The efficiency of the first design for which

$$X'X = \begin{bmatrix} N & 1 & 1 \ldots . 1 \\ 1 & N & 1 \ldots . 1 \\ 1 & 1 & N \ldots . 1 \\ \ldots\ldots\ldots\ldots\ldots \\ 1 & 1 & 1 \ldots . N \end{bmatrix},$$

the order of the matrix being $p \times p$ if there is zero bias, or $(p+1) \times (p+1)$ if there is bias, comes out to be

$$1 - \frac{p-1}{N(N+p-2)} \text{ for zero bias,}$$

or $$1 - \frac{p}{N(N+p-1)} \text{ for non-zero bias.}$$

It is surmised that this is probably the most efficient design available for these values of N and p. For the second design, the efficiency is $\frac{(N-1)p}{Np-1}$ for zero bias, or $\frac{N-1}{N}$ for non-zero basis.

For $N=2^m+r$, $p \leqslant 2^m$ (zero bias) or $p \leqslant 2^m-1$ (non-zero bias), r being any positive integer $< 2^m$ and m any positive integer, I have worked out two designs, which are exact analogues of the two designs just discussed. For the first design of this type, the efficiency is

$$1 - \frac{(p-1)r^2}{N[N+(p-2)r]} \text{ for zero bias, and}$$

$$1 - \frac{pr^2}{N[N+(p-1)r]} \text{ for non-zero bias.}$$

For the second design of this type, the efficiency comes to be $\frac{(N-r)p}{Np-r}$ if there is zero bias, and $\frac{N-r}{N}$ if bias is present.

Finally, when N is at our choice, we can always obtain a completely orthogonalized design by taking N equal to a sufficiently large power of 2.

A short paper giving details of these results has been sent to Prof. Harold Hotelling and is likely to be published in the *Annals of Mathematical Statistics*.

Dept. of Agriculture, U.P.,
Lucknow, K. KISHEN.
May 31, 1945.

1. Harold Hotelling, "Some Improvements in Weighing and other Experimental Techniques," *Annals of Mathematical Statistics*, 1944, **15**, 297–306. 2. Bose, R. C., "The fundamental theorem of linear estimation," *Proceedings of the Thirty-first Indian Science Congress*, 1944, Part 3. 3. Radhakrishna Rao, C., "On Linear Estimation and Testing of Hypothesis," *Current Science*, 1944, **13**, 154–155. 4. Kishen, K., "On Latin and Hyper-Græco-Latin Cubes and Hyper-cubes," *Current Science*, 1942, **11**, 98–99.

D.C.-A.C. VIBRO CONVERTER (50 C.P.S.)

A VIBRO converter unit has been designed and developed at the Department of Electrical Technology of the Indian Institute of Science, Bangalore, during 1944-45 on new lines and using indigenous materials. It converts 110/220 volts D.C. (mains supply) to 110/220 volts A.C. of square topped wave form (fundamental frequency of 50 cycles/sec.). Many difficult problems like the selection of proper contact material, the determination of the suitable make to break time ratio, the suppression of high voltage surge in the transformer secondary, etc., have been solved to make the design successful. The efficiency of the machine increases with the increase of load from 50 to 75 per cent., and the vibro converter is capable of supplying current up to 2 amps. with a voltage regulation of 3 to 4 per cent. Full details of the machine will be published elsewhere.

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Bangalore, R. N. DEWAN.
August 6, 1945.

MAGNETIC ANISOTROPY OF IODINE CRYSTAL

INFORMATION regarding the magnetic anisotropy of crystals of non metallic elements is scanty. In the case of metals, studies of the magnetic properties of crystals have been possible since large cylindrical crystals can be grown by the method of slow cooling. But with non metallic elements such methods are not applicable. Other lines of approach have to be considered.

One such method is the critical torsion method developed by Krishnan.[1] Small crystals can be employed and using fine quartz fibres, the magnetic anisotropy of any crystal can be accurately determined. Krishnan's method has been found to be successful in the case of elements as evidenced by the work of John[2] and Rao.[3]

In the case of iodine, Krishnan's method is ideal. Resublimed iodine crystals, having masses of about 100 mg., were employed. Test experiments proved that the specimen of iodine was free from any ferromagnetic impurity. Investigations on critical torsion were

made at field strengths of 8,000 oersteds. Fine quartz fibres were used, their torsion constants being determined by separate oscillation experiments.

Iodine crystallizes in the orthorhombic system.[4] Molecules of I_2 have their axes on the *ac* plane, these axes making angles of $+\phi$ or $-\phi$ with the *a*-axis. The atoms in an iodine molecule are 2·70 A apart. Between neighbouring molecules, the separation is 3·54 A in the *ac* plane and 4·35 A in adjacent planes. Cleavage takes place, therefore, easily along the *ac* plane.

With the cleavage face of an iodine crystal horizontal, it is easy to locate the *a* and *c*-axes. Investigations on five crystals gave the following average values for the principal specific susceptibilities.*

$\chi_a = -0{\cdot}354$, $\chi_b = -0{\cdot}331$ and $\chi_c = -0{\cdot}366$.

Since the iodine molecules lie in the *ac* plane, the specific susceptibility normal to the axis of the molecule becomes χ_b. With this simplifying assumption a calculation of the specific susceptibilities of the iodine molecule parallel and perpendicular to the axis, gives $\chi_{\parallel} = -0{\cdot}389$ and $\chi_{\perp} = -0{\cdot}331$. The corresponding gram molecular susceptibilities are 98·74 and 84·03 respectively. The angle ϕ works to 51°. The axes of the iodine molecules in the crystal are thus found to be inclined to the *a*-axis of the crystal at angles of $+51°$ or $-51°$. The available X-ray data do not appear to be specific on this issue.

Department of Physics,
Central College,
Bangalore, S. RAMACHANDRA RAO.
July 10, 1945. H. S. VENKATARAMIAH.

1. *Phil. Trans. Roy. Soc.*, 1935, **A 234**, 265. 2. *Zeits. Krist.*, 1939, **101**, 337. 3. *Jour. Mysore Univ.*, 1945, **5**, 69. 4. Wyckoff, *The Structure of Molecules*, 1931, p. 210.

* The susceptibility values are given in 10^{-6} unit.

'KYANOPHYLITE'—A NEW MINERAL OF THE HYDROUS ALUMINIUM SILICATE GROUP, DERIVED FROM KYANITE, FROM MAVINHALLI, MYSORE

ABOUT a mile and a half W.S.W. of Mavinhalli, in the ground consisting of the composite series of kyanite graphite schists, talc biotite schists, sillimanite quartz schists and other types of granulitic rocks, are found some loose bits and small lumps of an apple-green mineral which looks like some variety of talc or chlorites. It is, however, much harder than any of these minerals, and contains a large percentage of alumina and practically no magnesia at all. On chemical analysis, one of the specimens gave the following percentages:—

SiO_2–45·20; Al_2O_3–41·04; CaO·3·72; MgO–0·0; K_2O–0·73; Na_2O–3·84; Loss on ignition (mostly H_2O)–5·00.

The data show that it is essentially a hydrous aluminium silicate.

In thin sections the mineral forms feather-like aggregates, and shows fairly low refraction (about 1·58 to 1·60) and low birefringence,—the interference tints being low greys and hardly rising above yellow and red of the first order. In its physical and optical properties it does not correspond to any of the known varieties of the group of hydrous aluminium silicate minerals. The mineral forms a new type possessing its own individual characters, and will be described in detail in the next volume (XLIII) of the *Records of the Mysore Geological Department.*

Mysore Geological Dept.,
Bangalore, B. RAMA RAO.
May 23, 1945.

MIXTURES OF TETRYL AND T.N.T.

ACCORDING to Giua,[1] and Taylor and Rinkenbach,[2] tetryl (trinitrophenylmethylnitramine) and T.N.T. form a compound which melts at 67·6° C. and which contains the tetryl and the T.N.T. in the molecular proportion 1 : 2 respectively. Their conclusion is based on the presence of a very flat maximum in the melting-point diagram for tetryl/T.N.T. mixtures at a point which corresponds to the above proportions and melting-point. Efremov and Tikhomirova,[3] using a similar technique, reported that they could find no evidence for the existence of a compound.

As an alternative method of investigation we have determined the molecular weight of the alleged compound by measuring the depression of the freezing-point produced when it is dissolved in benzene. With three separate samples, prepared by melting the tetryl (m.p. 129·1° C.) and T.N.T. (m.p. 80·3° C.) together, figures of 233, 232 and 233 were obtained taking 51·2° C. as the molecular depression for benzene. These figures are, approximately, what would be expected from a mixture. The compound would have a molecular weight of 741.

In addition, it is possible to separate the tetryl and the T.N.T. by treatment with carbon tetrachloride at 0° C.[4]

Clearly, then, tetryl and T.N.T. in the molecular ratio 1 : 2 do not behave as a compound in solution at about 0-5° C.

We wish to thank the Director of Armaments for permission to publish this observation.

Inspectorate of Military Explosives, Kirkee, M. D. OWEN. J. VERGHESE.
May 24, 1945.

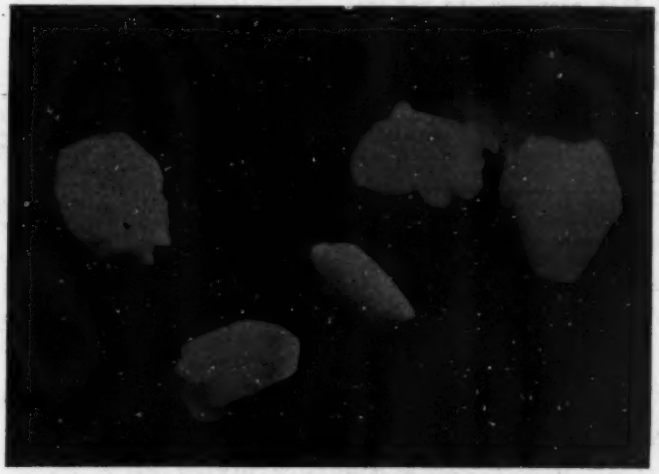
1. Giua, *Gaz. Chim. Ital.*, 1915, **45**, **2**, 32. 2. Taylor and Rinkenbach, *Ind. and Eng. Chem.*, 1923, **15**, 73. 3. Efremov and Tikhomirova, *Ann. Inst. Anal. Phys. Chim.*, 1926, **3**, 269–301. 4. Allen's *Commercial Organic Analysis*, **3**, 637.

A CHEMICAL METHOD FOR THE ESTIMATION OF ALKALOIDS PRESENT IN ARGEMONE OIL AND ITS APPLICATION TO A MIXTURE OF ARGEMONE AND MUSTARD OILS

ON account of its supposed role in causing epidemic dropsy argemone oil has received considerable attention in recent years. The theory is that when argemone oil is present in mustard oil as adulterant the ingestion of such mustard oil would produce epidemic dropsy in man. Lal *et al.*[1] were not able to substantiate this theory by isolating any toxic substance from this oil. The present authors[2] have, however, been able to isolate at least two toxic factors of alkaloidal nature from argemone oil. Whether they are responsible

for the development of symptoms of epidemic dropsy in man is a question that can only be settled by further work. The possibility, however, of the presence of toxic substances in edible mustard oil is dangerous from the standpoint of public health and as such attempts should be made to determine as accurately as possible the amount of argemone oil in an adulterated mustard oil sample.

The quantitative nitric acid method proposed by Lal *et al.*[3] for this purpose is not reliable for various reasons, *e.g.*, (i) the test is not specific—the colour being given by a number of substances, (ii) the supposition that in the case of argemone oil the development of colour is due to a single 'reacting substance' is no longer tenable and (iii) the equivalent amount of 'reacting substance' per c.c. of argemone oil as calculated from extinction coefficient data of 'Lal varies between 2-3 mgm. and this amount in its turn looks quite small in the light of our experience.



Picrate crystals from argemone o.l (Magnified)

Sarkar[4] developed a sensitive chemical test for the detection of argemone oil in adulterated mustard oil samples, the criterion of the positive test being the appearance of beautiful orange-red fibrous crystals. This substance has since been purified and has been found to be the hydrochloride of a nitrogenous base—the formula being $C_{19}H_{15}O_4NCl$. As it was soluble in ordinary solvents it was not suitable for quantitative work for which some insoluble or sparingly soluble derivatives of argemone alkaloids were being sought.

The picrate being practically insoluble in petroleum ether and very slightly soluble in ether was considered to be a suitable compound for the purpose. It was also possible to precipitate the picrate in a very good crystalline form (figure) directly from the oil. Conditions were developed to ensure maximum precipitation of picrates and an outline of the method thus developed is given below.

A known amount of argemone oil is taken in small stoppered flasks to which a definite quantity of acetone, ether and saturated etherial solution of picric acid are added. The flasks containing the mixture are kept aside for about forty-eight hours preferably in a refrigerator. After this, the crystalline picrate precipitate is transferred quantitatively into a weighed sintered glass crucible and then thoroughly washed with petroleum ether and ether (saturated with picrate) to remove oil and excess of picric acid. The crucible is then dried in a steam oven and weighed to constant weight. From this the amount of picrate formed from a known volume of oil can be found out. Taking a particular sample of argemone oil, 1·0 c.c. was equivalent to 10·1, 10·0, 10·1, 10·2 mgms. of picrate. Considering the difficulties associated with the isolation of substances directly from oil no better agreement between the observed values could be expected. Estimations can be carried out accurately with even 0·5 c.c. of argemone oil.

The method with practically the same degree of accuracy is applicable to a mixture of argemone and mustard oils. Good results have been obtained even when the percentage of argemone oil was very low—only 5 per cent. There is a point to be noted in this connection which is that in the case of oil-mixtures, a quantity equivalent to 0·5 c.c. of argemone oil should be taken and reagents added proportionately.

Full details will be presented elsewhere.

Our best thanks are due to Professors J. K. Chowdhury, F.N.I., and S. N. Bose, F.N.I., for their kind interest.

Biochemical Laboratory,
University of Dacca, S. N. Sarkar.
May 21, 1945. Md. Bazlur Rahman.

1. Lal *et al.*, *Ind. Jour. Med. Res.*, 1941, **29**, 839. 2. Sarkar and Rahman, *Curr. Sci.*, 1945, **14**, 201. 3. Lal *et al.*, *Ind. Jour. Med. Res.*, 1940, **28**, 163. 4. Sarkar, *Ann. Biochem. Exp. Med.*, 1941, **1**, 271.

CHEMICAL EXAMINATION OF *ERYTHRINA INDICA* (WHITE VARIETY)

THERE are two varieties of *Erythrina indica*, the white and the red. The former bears white flowers and yellow seeds. The latter is more common and better known. P. Suryaprakasa Rao and others[1] examined the seeds and bark of *Erythrina indica*. They did not mention whether they worked on the red or white variety. However, the author learnt from them that they examined the red one only. Hence he worked on the seeds of the white variety on precisely the same lines as the above workers.

The seeds of the white variety gave a reddish fixed oil (yield 12 per cent.) on extraction with petroleum ether and evaporation of the solvent from the extract. A comparative statement of the usual constants of the oils from both varieties is given below.

	Oil from white variety (author)	Oil from red variety (P. S. Rao & others)
Specific gravity	0·8603 at 30° C	0·8821 at 30° C
Refractive index	1·4400 at 30° C	1·4596 at 30° C
Saponification value	185·5	184·5
Iodine number	31·84	63·3
Acid number	9·5	1·24

The two oils agree in all properties except the iodine and acid numbers.

The alcohol extract of the oil-free seeds gave a white crystalline alkaloid nitrate. Analysis and study of its properties showed that it was same as hypaphorine nitrate isolated from the red seeds. The two varieties of *Erythrina indica*, therefore, contain the same alkaloid, namely, hypaphorine.

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P. R. College,
Cocanada, J. VIRABHADRA RAO.
May 7, 1945.

1. *Proceedings of the Indian Academy of Sciences* 1938, 179–185.

A NATURAL CONCENTRATE OF VITAMIN A

RAJGOPAL[1] recently reported a very high potency of 1,90,400 I.U./G. (Carr-Price value 3735) for a Sind shark liver oil. No oil of about this potency had been so far extracted in this Presidency. Such a very highly potent oil was extracted recently from livers of very small sharks belonging to *Carcharias* spp. and measuring 1 foot to 1¾ feet and caught on the west coast. Thirty-nine pounds of these livers yielded 12 pounds of oil. Testing the whole oil in a B.D.H. pattern Lovibond Tintometer, a Carr-Price value of 3176 was obtained. Using the factor 54 for conversion of Carr-Price value into international units, as recommended by Rajagopal,[2] the vitamin A potency of this oil can be expressed as 1,71,500 I.U/G.

The oil was further analysed and the following characteristics were recorded:—

Colour	Deep reddish orange
Specific gravity 35°C.	0·9229
Refractive Index 35°C	1·4889
Saponification value	160·7
Iodine value Wijs	144·9
% un-saponifiable matter	18·4
Iodine value of the unsaponifiable matter	302·4

The very high iodine value for the unsaponifiable matter is noteworthy, but was expected from its high content of the unsaturated vitamin A.

It is further difficult to understand the object of such a natural concentrate of vitamin A in such small sharks. In elasmobranchs, perhaps, vitamin A may have some physiological role, as yet unassigned to this nutrient in human metabolism.

Thanks are due to the Director of Industries and Commerce, Madras, for permission to publish this note.

Technical Research Lab.,
Government Oil Factory,
Calicut, ULLAL SUNDAR KINI.
May 1, 1945.

1. Rajagopal, K., *Curr. Sci.*, 1942, **11**, 52. 2. —, *Ind. J. Med. Res.*, 1941, **29**, 575.

LOBELIA NICOTIANAEFOLIA HEYNE AS SUBSTITUTE FOR *LOBELIA INFLATA* LINN., B.P.

IN connection with the preparation of an 'Indian Pharmacopœial List' which is expected to serve as a Supplement to the British Pharmacopœa in India, work has been undertaken at the Biochemical Standardisation Laboratory of the Government of India to assess critically the 'replacement' value and possibilities of a number of likely Indian substitutes of well-known pharmacopœial drugs. The note given here represents investigations on *L. nicotianæfolia* Heyne as a possible substitute for *L. inflata* of the B.P., a drug fairly extensively used in asthma and similar conditions.

Datta and Bal[1] have already reported on the pharmacognistic characters of *L. nicotianæfolia* and have shown its close resemblance in this respect to *L. inflata*, the official drug. Extensive chemical and clinical trials were, however, called for before adopting the Indian Lobelia as a true, efficient and harmless substitute for the pharmacopœial drug. The chemical investigations carried out in this direction are given below in tabular form. The method of Lynn and Evers[2] was employed, for the estimation of lobeline.

No.	Species of *Lobelia*	Source	Coll. time	Parts used	Tot.alk. as Lobeline	Acid-insol. ash
1	*L. nicotianæfolia*	(*a*) Poona area	Oct.-Nov.	Stems & flowering tops	1·18 %	0·23 %
		(*b*) Do.	Do.	Do.	1·16 %	0·21 %
2	,,	(*a*) Tellichery Madras	Sept.	Flowering tops	1·04 %	1·3 %
3	,,	(*b*) Madras	June-July (during rains)	Aerial parts with flowering tops	0·32 %	0·26 %
4	,,	Not known (recd. through Herbal Herald & Co., Ltd.)	Not known	Do.	0·168%	0·3 %
5	*L. nicot.* (?) (possibly *V. thapsus*).	Not known (recd. through a Cal. firm.	Rainy season	Leaves chiefly	0·105%	0·26 %
6	*L. nicot.* (?) (identified as *V. thapsus*)	South India (recd. through Sepulchre & Co., Cal.)	Not known	Leaves & a few slender twigs	0·117%	0·20 %
7	*L. inflata* (official species)	New York, U.S.A.	Not known	Stems, flowering tops, leaf powder	0·32 %	2·38 %

The table shows conclusively that Indian lobelia, provided it is collected during October-November from suitable areas, is a better substitute than the official B.P. or U.S.P. drug. In a good sample (No. 1*a*, 1*b*), the lobeline content, which is acknowledged to be the chief active ingredient of the drug, is almost four times as high (1·18 per cent.) as an authentic official sample of *L. inflata* obtained from New York through the courtsey of Mr. S. N. Bal, Officer-in-charge of the Industrial Section of the Indian Museum. Samples collected during the rainy season are poorer in alkaloidal content but the lobeline content is still on a *par* with (0·32 per cent.) the average alkaloidal content of *L. inflata*. In certain samples, the lobeline content was found to be as low as 0·117 per cent. Doubt was, therefore, expressed as to whether this sample represented true *L. nicotianæfolia*. Pharmacognostic examination by Indian Museum, Botanical Survey of India, revealed that this sample was from *V. thapsus*, a common adulterant of true lobelia.

From the different parts of the plants (flowering tops, stems, leaves, whole plants, etc.), forwarded to the Laboratory for examination, it appeared that the collectors have hardly any idea as to the part or parts of the plant to be used for pharmaceutical and medicinal purposes. The B.P. 1932 recommends the use of 'dried aerial parts which should not consist of more than 60 per cent. stems'. From differential assay of the various aerial parts of the plant, the following average results were obtained on duplicate analyses of two specimens :

(1) Leaves only—0·64 per cent. lobeline.
(2) Stems only (thin hollow stems, 1-3 cm. diameter)—0·43 per cent. lobeline.
(3) Thick bottom stems—0·21 per cent. lobeline.
(4) Flowering tops only—1·41 per cent. lobeline.

A good sample of Indian lobelia, therefore, should contain chiefly flowering tops and slender top stems and leaves. The thick portion of the stems near the ground (though it is included within the description of 'aerial parts') should be discarded.

For clinical trial, an ethereal tincture was prepared from *L. nicotianæfolia* in the same way as prescribed in the B.P. 1932. By admixture in suitable proportions of Lobelia having higher or lower alkaloidal content or by the addition of exhausted Lobelia, the tincture was adjusted to a lobeline content of 0·3 per cent., more or less the same lobeline content as was obtained from the New York sample of *L. inflata*. This tincture was freely used in 5-15 minim. dosage in simple asthma mixture containing Potassium Iodide and Tincture Belladonna and was found to be quite efficacious and without any untoward effects. A mixture with only Tinct. Lobelia Etheris (from Indian Lobelia) was also used, but this did not prove as effective. This is only to be expected as Tinct. Lobelia acts best as an anti-spasmodic in a synergistic combination with other parasympathetic depressants of the bronchial musculature.

We are, therefore, in a position to recommend the extended use of *L. nicotianæfolia* in place of *L. inflata*, wherever this drug is indicated. *L. nicotianæfolia* should preferably be collected in winter months (October-November) and its thin top stems, leaves and flowering tops should be used as the crude material from which tinctures should be prepared. The liquid preparation should be adjusted to have a lobeline content of 0·3 per cent., and may then be administered in the same dosage as recommended for the 'official' drug in the B.P., 1932.

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110, Chittaranjan Avenue, B. MUKERJI.
Calcutta, S. K. GHOSH.
May 25, 1945.

1. Datta and Bal, *Science & Culture*, 1944-45, **10**, 260. 2. Lynn and Evers, *Analyst*, 1939, **64**, 381. 3. B. P., 1932, Constable & Co., London, 275.

CONCENTRATION OF RUBBER LATEX BY CREAMING

THE concentration of rubber latex by creaming was first noticed by Traube.[1,2] Since then creaming has been used on a large scale in the preparation of latex concentrates. The creaming agents generally used are gums, pectins, gelatin, alginates and other similar hydrophilic colloids.

While working on the concentration of rubber latex the author has found that the seeds of *Adenanthera pavonina* (Coral Wood) provide a new source of creaming agent for rubber latex. Coral wood tree is found in the Himalayas, Western Ghats and Sylhet.

A convenient quantity of the powdered seeds was kept soaked in five to six times its weight of water for about four hours. The aqueous solution was decanted off, and the pasty mass mixed with seven to eight times its weight of water, and heated at 80° to 90° for about four hours. It was then filtered, and filtrate concentrated to about one-fourth of its original volume. Ninety-five per cent. alcohol was then added in such quantities that the final concentration of the alcohol did not go below 70 per cent. The flocculent precipitate that was formed was filtered, washed, dried and powdered. The yield of the material was about 5 to 6 per cent. based on the dry weight of the seeds. For concentration of rubber latex a 2 per cent. aqueous solution of the above powder was used.

To rubber latex of 30 per cent. D.R.C., was added 0·2 per cent. (based on aqueous phase) of the creaming agent. After thorough mixing the rubber latex was kept undisturbed. Creaming started in about an hour, and was complete in about 12 to 14 hours. A cream of 58 to 60 per cent. D.R.C. separated at the top. The serum was found to contain less than 0·5 per cent. rubber.

This creaming agent gave the following reactions, usually characteristic of pectins:—

(1) Ten c.c. of a 1 per cent. aqueous solution of the creaming agent when mixed with 1 c.c. of a 10 per cent. solution of thorium nitrate set to a firm gel in about two minutes. This gel-formation was not observed in the presence of acetic acid.[3]

(2) Addition of calcium chloride solution to an aqueous solution of the creaming agent in presence of acetic acid resulted in the precipitation of calcium pectate.[4,5]

Further details will be published later.

The author's thanks are due to Sir Jnan Chandra Ghosh, KT., D.SC., F.N.I., for his keen interest in this work.

General Chemistry Lab.,
Indian Institute of Science,
Bangalore, GEORGE T. VERGHESE.
June 28, 1945.

1. Traube, *Brit. Pat.*, 1924, 226, 440. 2. —, *Gummi Ztg.*, 1925, **39**, 434, 1617. 3. Bryant, *Ind. Eng. Chem.* (Anl. Ed.), 1941, **13**, 103. 4. Carre and Hayne, *Biochem. J.*, 1922, **16**, 60. 5. Nanji and Norman, *Ibid.*, 1928, **22**, 596.

FERRIC TUNGSTATE GEL

IN communications[1] from these laboratories the conditions of preparation of several ferric sols have been described. In this note the condition of formation of ferric tungstate gel has been investigated. Holmes[2] obtained gels of ferric phosphate and chromic arsenate. Ferric borate sols and gels were obtained by Prakash and Dhar.[3] Prakash[4] obtained a gel of ferric tungstate for the first time by mixing a 15 per cent. solution of sodium tungstate with M/2 ferric chloride solution.

I have observed that in presence of glucose ferric chloride dissolves a considerable amount of sodium tungstate to give a deep red positively charged sol of ferric tungstate. If this sol be purified by dialysis and then coagulated by electrolytes it sets to transparent jellies with slight opalescence.

To 50 c.c. of ferric chloride solution (corresponding to 69·84 gm. of Fe_2O_3 per litre) was added 10 c.c. of 20 per cent. glucose solution and 40 c.c. of 10 per cent. Na_2WO_4, $2H_2O$ was slowly run into this mixture. The mixture was vigorously shaken and was then allowed to dialyse for three days. The purified sol thus obtained had the empirical formula $2\ Fe_2O_3 . Fe_2(WO_4)_3$ and set to jellies when coagulated with KCl or K_2SO_4.

The influence of the variation of the concentration of the coagulating electrolyte on the time of setting of the gel is shown in the following tables:—

TABLE I

Amount of sol taken = 3 c.c.; Total volume = 6 c.c.

Amount of N/50 K_2SO_4 (c.c.)	3	2·8	2·6	2·4	2
Time of setting (Minutes)	14	40	70	140	No jelly

TABLE II

Amount of sol taken = 2 c.c.; Total Volume = 4 c.c.

Amount of N/2 Kcl (c.c.)	2	1·9	1·8	1·7
Time of Setting (Minutes)	5	13	30	No jelly

It has been further observed that this sol itself sets to a transparent jelly when kept in a Jena bottle for about fifteen days.

The author expresses his deep gratitude to Dr. Satya Prakash for guidance during the progress of this work.

Chemical Research Laboratory,
Allahabad University, S. P. MUSHRAN.
June 15, 1945.

1. Prakash and Mushran, *Allahabad Univ. Studies*, 1943, **19**, 1; Mushran, *Curr. Sci.*, 1945, **14**, 123. 2. Holmes and Co-workers, *J. Amer. Chem. Soc.*, 1918, **40**, 1014. 3. Prakash and Dhar, *J. Ind. Chem. Soc.*, 1930, **7**, 367. 4. —, *Ibid.*, 1929, **6**, 587.

ISOLATION OF SOME TOXIC FACTORS FROM ARGEMONE OIL

ARGEMONE OIL has been held to be the factor responsible for causing epidemic dropsy in man by a number of investigators especially by Lal *et al.*[1] Sarkar[2] pointed out certain anomalies of the theory and stressed on the fact that a definite solution of the problem could

only be arrived at by isolating the active substances both from the argemone oil and the toxic mustard oil and then showing that they were chemically identical and that they also possessed similar physiological properties.

In their latest communication on the subject, Lal *et al.*[3] stated that the nitrogenous bases they had been able to separate, so far, were not toxic to man but might produce some histological changes in albino rats without any mortality however. They suggested that the substances they had been able to isolate formed part of an original complex toxic molecule. Their attempts to recombine the split products into this hypothetical toxic molecule did not materialise.

Attempts were made, therefore, to isolate compounds from argemone oil in various ways and to see if any of them were toxic. Accordingly, a number of compounds giving tests for alkaloids were obtained from this oil by (1) saponification method of Lal *et al.*,[4] (2) HCl gas extraction method of Lal *et al.*,[4] (3) ferric chloride method of Sarkar,[5] (4) extraction with cold dilute hydrochloric acid, 1 : 4, and (5) precipitating the nitrogenous bases as picrate.

By methods (3) and (4) hydrochlorides of base or bases were obtained directly. Compounds obtained by the other methods were converted into hydrochlorides with great difficulty.

The toxicity of these compounds were then tested by administering to young albino rats aqueous solution of various hydrochlorides orally in 1 mgm. daily doses. It was observed that hydrochlorides of compounds obtained by methods (1) and (2) were not much toxic but those obtained by methods (3) and (4) were definitely toxic having produced more than 50 per cent. mortality within 30 and 44 days respectively. The hydrochloride obtained from the picrate (method 5) appeared to be the most toxic since there was cent. per cent. mortality. It was even fairly toxic in 0·5 mgm. dose as there was 50 per cent. mortality within 22 days.

Further investigation showed that this picrate was a crude mixture from which so far two definite fractions could be isolated. One of them (Fraction I) is of light yellow colour and the other one (Fraction II) was of red colour.

Fraction I after several recrystallisations melted at 220-222° C. with decomposition. Toxicity determinations carried out with 1 mgm. daily dose of the hydrochloride as before showed that this fraction was much more toxic and two out of three rats died within a week. The post-mortem examination showed that there was punctate hæmorrhage in the liver with marked congestion, the heart was dilated and there was passive congestion in lungs and kidneys. There was also a marked bloating up of the intestine and stomach. The animals appeared to have developed a limpid gait before death showing paresis of hind legs. In addition there was a marked dyspnœa and the condition of rats was very low.

Fraction II after several recrystallisations melted at about 250° C. with decomposition. The hydrochloride from this picrate was also very toxic as there was cent. per cent. mortality within 23 days. The post-mortem examination showed that the liver was congested and there were hæmorrhagic patches here and there. The heart was dilated and in lungs hæmorrhage was noticeable. The kidney showed signs of passive congestion.

Argemone oil, therefore, contains at least two toxic compounds. It should be borne in mind, however, that mere isolation of two toxic substances does not necessarily imply that they are really the causative factors in epidemic dropsy and to settle this point satisfactorily other data would be necessary.

Further work is in progress and details will be published elsewhere in due course.

Our best thanks are due to Professors J. K. Chowdhury, F.N.I., and S. N. Bose, F.N.I., for their kind interest.

Biochemical Laboratory,
University of Dacca, S. N. Sarkar.
May 21, 1945. Md. Bazlur Rahman.

1. Lal *et al*, *Ind. Jour. Med. Res.*, 1939, **27**, 207. 2. Sarkar, *Ann. Biochem. Exp. Med.*, 1941, **1**, 59, 203. 3. Lal *et al.*, *Ind. Jour. Med. Res.*, 1941, **29**, 839. 4. —, *Ibid.*, 1941, **29**, 361. 5. Sarkar, *Ann. Biochem. Exp. Med.*, 1941, **1**, 271.

CUPRIC PENTAMMINO-SULPHATE

The deep blue liquid obtained by dissolving copper sulphate in a solution of ammonium hydroxide has been studied by numerous workers. C. Immerwahr[1] suggested that in the solution Cu^{++} ions are replaced by more complex cupric-amino ions. A. Reychler,[2] D. P. Konowaloff,[3] W. Gaus,[4] and J. Locke and J. Forsall,[5] by freezing point, absorption and vapour pressure measurements respectively found the compound formed to be $Cu(NH_3)_4SO_4$. H. M. Dawson and J. Mc Crae,[6] D. W. Horn,[7] A. A. Blanchard,[8] P. Job,[9] S. Glasstone[10] and others have all found the same formula by various means. S. S. Bhatnagar, D. N. Goyle and M. Prasad,[11] however, ascribe the blue colour of the solution to colloidal copper hydroxide. In a recent communication[12] we have reported the existence of bi-, tetra-, penta- and hexa-amino compounds in the solution.

A blue amino compound was isolated by adding alcohol to the blue solution of ammoniacal copper sulphate. This compound was filtered, washed with alcohol and decomposed by adding a solution of caustic soda when black copper oxide precipitated out and was estimated. The ammonia evolved was absorbed in a standard sulphuric acid solution and was then estimated. As a result of the analysis the amounts of both copper and ammonia were known and the $Cu : NH_3$ ratio was found to be 1 : 5. The compound thus isolated, which was so far called to be the tetramino compound, was now found definitely to the cupric pentamino sulphate.

Detailed procedure and results of the method

will be described in a subsequent communication.

Chemical Laboratory,
The University, ARUN K. DEY.
Allahabad, A. K. BHATTACHARYA.
April 14, 1945.

1. Immerwahr, C., *Zeit. anorg. chem.*, 1900, **24**, 269. 2. Reychler, A., *Bull. Soc. chim.*, 1895, **13**, 3, 387. 3. Konowaloff, D. P., *J. Russ. Phys. Chem. Soc.*, 1899, **31**, 910. 4. Gaus, W., *Zeit. anarg. chem.*, 1900, **250**, 259. 5. Locke, J., and Forsall, J., *Amer. Chem. Jour.*, 1904, **31**, 268. 6. Dawson, H. M., and Mc Crae, J., *J.C.S.*, 1900, **77**, 1239. 7. Horn, D. W., *Amer. Chem. Jour.*, 1907, **38**, 476. 8. Blanchard, A. A., *J. Amer. Chem. Soc.*, 1904, **26**, 1315. 9. Job, P., *Compt. rend.*, 1927, **184**, 206. 10. Glasstone, S., *J.C.S.*, 1932, 2849. 11. Bhatnagar, S. S., Goyle, D. N., and Prasad, M., *Kell. Zeit.*, 1928, **44**, 79. 12. Bhattacharya, A. K., and Dey, A. K., *Curr. Sci.*, 1945, **14**, 3, 69.

JUTE FABRIC-SHELLAC LAMINATES

I WAS most interested to read the extracts from an address delivered by Sir S. S. Bhatnagar at the Central India Centre of the Institute of Engineers (India), as given in the issue of *Current Science* for May 1945. That scientific achievements born of war necessity have been literally prodigious is no understatement and numerous examples have been given in Sir Shanti's address. There is little doubt also that many, if not most, of these achievements will be turned to good use for the benefit of the community in the post-war years. Much has been written of India's contribution to the war effort, but possibly much more still remains to be written as and when facts can be made known, although in all probability those most closely associated with new developments will remain true to tradition and prefer to remain anonymous.

Mention has been made in the address of unburstable containers and jettison tanks; also of fabric laminates for use in the fabrication of car bodies and made from jute or canvas cloth in combination with plastics. Since these are manufactures of which considerable practical and production experience already exists, I would like to take this opportunity, through your columns, of making reference to a jute fabric-shellac laminate which has been in full-scale production for nearly three years and has not only done service for the uses mentioned, but even greater service for many other uses of importance to the war effort. This fabric laminate is a 100 per cent. Indian indigenous product, is manufactured by a novel process, essentially simple in principle, and uses in its manufacture the natural resin shellac, or modifications thereof. Detailed production figures cannot be given for certain reasons but it can definitely be stated that the product has created during its relatively short existence a very large additional outlet for both jute fabric and shellac. A measure of publicity will be given in due course but a brief history of its development may be of interest.

The product to which I refer is termed "JUTLAC" and was developed at the express request of one of the large oil companies in India and also to assist the tea industry. In the case of the former to produce substitute grease containers in place of black sheet metal, and in the case of the latter, to provide a robust and reliable substitute for imported plywood. These approaches were made to the Research Institute of the Indian Jute Mills Association towards the end of 1941, when circumstances and conditions were approaching their very worst, and they were made as something of a last resort some considerable time after similar approaches had been made to official Research Institutes and Institutions in India. It was emphasised that more than samples must be produced that the raw materials required should be readily available in India, and that production had to be obtained in the shortest possible time. The obvious choice for raw materials were jute fabric and shellac, both of which were readily available, and in sufficient quantity. As a result, the I.J.M.A. Research Institute in its turn made an approach to a well-known Calcutta firm of shellac manufacturers who had been similarly approached to provide other substitutes by the Directorate-General, Munitions Production. By combining resources and technical skill it was possible not only to evolve a practical method of manufacture, which could be done on relatively simple plant, but such plant was constructed in the workshops of the firm concerned and subsequently in those of specially selected Calcutta jute mills. There was no question that when Calcutta eventually became a danger zone, production would have to be abandoned, and such was fully maintained throughout this somewhat difficult period.

The production of fabric laminates under normal conditions is well established practice and in the main consists of bonding resin-impregnated fabrics under heat and pressure in hydraulic presses. Such methods could not be put into practice in India to give even reasonable production, because, firstly, industrial presses of the type required were either not available, or only available in negligible numbers, and in any case the production of the latter would most probably have been taken up in other directions. Secondly, spirit solvents or other vehicles are generally used for dissolving the resin and the supply of sufficient industrial spirit, then on very short supply, was not available for release. Had spirit been available in sufficient quantity, solvent recovery units would have been required to make the process even reasonably economic, and finally, the capital cost of installation of hydraulic presses with all the accessory equipment required would have been enormous if the production required was to be obtained. Each and all of these difficulties which blocked large-scale production of fabric laminates, with circumstances as they were, do not exist in the processes for "Jutlac" manufacture and the resulting product is characterised by its toughness and flexibility.

Many millions of square feet of this product have been produced and it is fitting to record that the first machine was built and in pro-

duction early in 1942, only a matter of months after the original approaches to produce a black sheet metal and plywood substitute were made.

As regards the uses to which the product has been put, only a few need be mentioned as examples. Hundreds of thousands of grease drums have been made and many hundreds of thousands of tea-chests. Some three-quarters of a million "Jutlac" liners for supply-dropping equipment have been produced and hundreds of thousands of square feet supplied and used in the fabrication of military vehicles. As regards jettison petrol tanks for aircraft, several hundred were fabricated which passed all tests satisfactorily; these tanks were chiefly of 45 gallon capacity but also larger tanks of 90 gallon capacity were made. Plans were ready to expand production of these tanks but such did not have to come into operation because of a fortuitous change in the situation. "Jutlac" has been used by the British Military and Air Force Services and by the U.S.A.A.F.; it has been used by the tea industry, the oil industry and by other large industries. It has been used in building construction, for panelling, for racking and for boxes. It also makes serviceable suitcases. Moreover, it has been successfully used, and complaints from the users have been practically nil, perhaps a fitting tribute after three years' experience in usage for so many different purposes. As already stated the material is 100 per cent. an Indian indigenous product, evolved, developed and put into production during a very difficult period. A large-scale research and development plan is in course of projection, which will open out possibilities for the establishment of a new industry entirely indigenous to India.

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Indian Jute Mills Association,
Calcutta, W. G. MACMILLAN.
June 6, 1945.

DETERMINATION OF TOTAL SOLIDS IN MILK

DURING our experience of examination of milk for the prevention of adulteration under the Bombay Prevention of Adulteration Act, it has been found that the Total Solids of milk, when calculated by means of Richmond formula, is generally in excess than that determined by direct gravimetric method. Moreover, when the milk is adulterated either by abstraction of fat, watering, or both, this discrepancy between the two methods is found to be high (see table).

This is so, because the specific gravity of milk is raised by the abstraction of fat and lowered by the addition of water. Hence, by partial skimming and watering, an adulterated sample may possess the same specific gravity as that of genuine milk. In such a case, the Total Solids calculated by Richmond formula will be found higher than the actual present in milk, inasmuch as it will not take into account the adulteration of water, as the specific gravity will be that of genuine milk, even though abstraction of fat will be accounted for. For such cases, no formula, either for buffalo or cow milk will satisfactorily work,

Sample No.	Specific Gravity, at 60°F.	Fat %	Total Solids %, by Richmond formula	Total Solids %, by gravimetric method	Excess. By formula
1	1·027	3·4	10·9	8·6	2·3
2	1·023	2·8	9·2	7·0	2·2
3	1·033	3·8	12·9	9·9	3·0
4	1·025	3·0	10·0	8·2	1·8
5	1·023	2·6	9·0	5·8	3·2
6	1·023	2·8	9·2	7·3	1·9
7	1·036	6·8	16·3	15·0	1·3
8	1·037	5·4	15·9	12·6	3·3
9	1·029	4·8	13·1	10·6	2·5
10	1·033	5·6	15·1	12·2	2·9
11	1·034	5·1	14·7	10·9	3·8
12	1·029	4·4	12·6	10·0	2·6
13	1·026	4·2	11·6	9·1	2·5
14	1·042	6·0	17·8	14·2	3·6
15	1·042	6·8	18·8	15·2	3·6
16	1·027	2·3	9·6	8·1	1·5

because specific gravity of milk varies directly as abstraction of fat and inversely as addition of water. Whether, therefore, the specific gravity is normal or otherwise, it is necessary to determine the fat and total solids by gravimetric method.

In this Province Total Solids in milk are calculated on the Richmond formula, in some of the Public Health Laboratories, while in others, by the direct gravimetric method. In view of this, when milk samples under Bombay Prevention of Adulteration Act are sent for analysis from one part of the Province to another, the results are found to be different. Due to this, the accused is given benefit of doubt and acquitted. Hence uniformity of standards as well as methods of analysis and calculation should be laid down by the Central Advisory Board for Food Adulteration, Government of India, for milk and its products.

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Borough Municipality,
Surat, C. M. DESAI.
A. H. PATEL.
June 26, 1945.

TAMARIND SEED "PECTIN"

NANJI *et al.*[1] pointed out in a recent issue of this *Journal* that the "pectin" prepared from tamarind seed according to the method of Krishna and Ghose[2] is "not a pectin as ordinarily understood" as it fails to give some of the characteristic pectin reactions and as it contains nitrogenous material. We had occasion to deal with this substance in the course of a systematic investigation on pectins from Indian plant materials completed in this laboratory some time ago and, after examining it in some detail, reached the conclusion that it was not a pectin. The investigation was undertaken mainly with the object of discovering a source of galacturonic acid required for the

technical synthesis of vitamin C. Tamarind seed was the first raw material to be examined as it was stated to contain 60 per cent. of pectin and was available in quantity. But the substance prepared according to the directions given by Krishna and Ghose[2] failed to yield on acid hydrolysis any appreciable quantity of galacturonic acid. When analysed for the calcium pectate number by the quantitative method of Carreè and Haynes,[3] tamarind seed meal gave a zero value indicating the absence of pectin. For further study the material prepared as above was hydrolysed with acid. Hydrolysis with 3 per cent. sulphuric acid for eight hours gave the maximum yield of reducing sugar, *viz.*, 83 per cent. of the weight of substance taken. In this hydrolysate the only sugars that could be identified were *l*-arabinose and *d*-glucose. The following quantitative estimations were carried out on the preparation: methoxyl (micro-Zeisel), uronic acid by determination of the carbondioxide evolved on decarboxylation (Dickson, Otterson and Link),[4] pentose from the amount of furfuraldehyde formed on hydrolysis with 12 per cent. hydrochloric acid (Doree).[5] From these analyses the substance was found to contain methoxyl 1·08 per cent., uronic acid residues 12·59 per cent., araban 33·22 per cent., glucosan 53·11 per cent. Krober's[5] tables were used for calculating the pentosan content; the correction for the furfuraldehyde derived from uronic acid was based upon Norris and Resch.[6]

It is obvious from these results that the substance is not a pectin although it shares with pectin the useful physical property of forming sugar-acid-jellies. Pectin is now known to be a macro-molecule consisting essentially of a chain of galacturonic acid residues in glucosidic union with each other, some of the galacturonic acid units being in the form of the methyl ester (*cf.* Morrell, Bauer and Link;[7] Schneider *et. al.*[8,9,10]). There is at present insufficient evidence to conclude whether the arabinose and galactose usually obtained from pectin preparations are in true chemical combination with the galacturonic acid or only arise from associated galactants and arabans which are not removed in the ccurse of preparation. For the uronic acid content, values as high as 96%[9] has been claimed for specially purified pectins. Ordinary commercial preparations usually contain about 68%[11] uronic acid. The corresponding methoxyl values are 11·6%[9] and 6%[11] respectively.

The low methoxyl and uronic acid content of the tamarind seed preparation as well as the nature of the sugars derived from it preclude the possibility of it being classed with the pectins. It has greater similarity in chemical composition to the mucilages isolated from certain seeds (*cf.* mucilages from Psyllium,[12] rib grass seed,[13] Indian wheat[14]) which contain in general pentose and hexose sugars in combination with only a small proportion of uronic acid.

M. Damodaran.
P. N. Rangachari.

University Biochemical Laboratory,
Madras,
July 12, 1945.

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PROCESSING OF SOYA-BEAN FOR THE PRODUCTION OF MILK

During recent years, milk shortage in India has assumed alarming proportions. Attention of the public to this important point has been focussed by the daily press. *Indian Farming*[1] has published some important statistical information regarding the extent of shortage. The annual production of milk in India is estimated to be 800,000,000 maunds; but the *per capita* consumption of milk is only 7 ozs. per day compared to 35 ozs. in U.S.A. The minimum requirement of milk for a growing child is 32 ozs. and 16 ozs. for an adult; so, the supply of milk should be increased to at least three times the present production. This production cannot be achieved for several years to come; so, our attention was directed to the possible utilisation of soya-bean to make up the deficit in our milk supply.

The soya-bean milk has been extensively used throughout the Orient since its discovery by the Chinese philosopher, Wahi Nain Tze-lang, some time before the Christian era. In China the soya-milk is being prepared and used in every household as a daily routine. The soya-bean milk is usually prepared by first soaking the beans for a few hours in water. They are then crushed into a fine texture mash. This is boiled for some thirty minutes in the proportion of three parts water to one of mash. The 'milk' is then filtered through cloth. The 'milk' thus obtained is not very palatable and is slightly coloured. Prepared in the above manner, the nutritive value is also not high. In view of these, we concentrated our attention on the improvement of processing and have been able to prepare a 'milk' which has an agreeable taste and has, at the same time, a good nutritive value.

The nutritive value of soya-bean milk has already been the subject of some study. Tso[2] fed infants successfully with soya-bean milk prepared in the ordinary way and found that in 8 months an average child grew 20·7 cm. and gained 4·1 kg. in weigh, a growth record which compares favourably with the average development of breastfed infants. Rittinger and Dembo[3] fed fifty infants for a period of one year with addition of sugar and various salts and they concluded that soya-milk can be made into an adequate food for infants. Recently, Cahill *et al.*[4] studied the biological value of soya-milk prepared by Borden & Co.

on human subjects and found that the biological value of the 'milk' is 95 when egg protein is taken as the standard. The method of manufacture is not given.

That the nutritive value of raw soya-bean is not good has been shown by the researches of Osborne and Mendel[5]. They found that raw soya-bean when fed to rats as the sole source of protein in an otherwise complete ration did not support appreciable growth. However, normal growth resulted when they fed soya-beans which had been previously cooked. Hayward *et al.*[6] have shown that the expeller process soya-bean meal contains proteins which have twice the nutritive value of raw soya-beans. Everson *et al.*[7] from growth-studies on young rats have found that germination increases the biological value of the protein to more than triple the original value. Germination not only increases the nutritive value of the protein, but the vitamin content is also greatly increased.[8] The riboflavin and nicotinic acid content are increased to more than double the original value.

In view of the foregoing observations, we tried to prepare soya-milk from the germinated bean. Another advantage of the germination is that it makes the beans more palatable. The procedure employed by us for the production of milk is as follows:—

Take 1 lb. of soya-bean and soak it in sufficient water for 5 hours, then put it in bags and suspend in an open place for 48 hours. The bags are soaked thrice daily in water to keep the seeds moist. By this time, the seedlings attain an average length of ½ cm. The seeds are then freed from the adhering skin by rubbing with hand. The next procedure is the removal of the bitter principle and the colouring matter and this is largely effected by heating the seeds at 70° C. for 30 minutes with four times its weight of water. Addition of 0·2 per cent. sodium bicarbonate or 1 per cent. glycerine to the extracting water improves the efficiency of extraction. The water extracting the colouring matter and the bitter principle is thrown away and the beans are washed thoroughly with hot water. The clean kernel is then made into a fine paste. This can be done in any suitable wet grinding machine if the 'milk' is to be prepared on a large scale. The pasty mass is then boiled with four times its weight of water for half an hour. The 'milk' is strained through cloth. Two per cent. sugar and 0·5 per cent. calcium lactate or gluconate may be added to improve the taste and calcium content. The average composition of the 'milk' thus obtained is as follows:—

Total solids—10·1 per cent.
Protein—4·2 per cent.
Fat—3·4 per cent.
Carbohydrates—1·8 per cent.
Salts—0·7 per cent.

The keeping quality of soya-milk is better than that of ordinary milk and the 'milk' is fairly stable. The growth response of young rats fed on soya-milk is 90 per cent. of that obtained with pure cow's milk. The digestibility and the biological value of the proteins of the 'milk' have been found to be 90 and 81 respectively. The vitamin content of soya-milk as prepared by the above method as compared with that of cow's milk (average of six samples) is as follows:—

Vitamin contents per litre of milk

	Soya milk	Cow's milk
Vitamin A (as carotene) ..	750 I.U.	1050 I.U.
Thiamine	0·82 mg.	0·43 mg.
Riboflavin	1·10 mg.	1·32 mg.
Nicotinic acid	2·49 mg.	1·16 mg.
Ascorbic acid	21·60 mg.	17·84 mg.

From the above results, it will be seen that soya-milk as obtained by the improved method is nearly as good as and in some respects, even superior to good cow's milk. Further investigations bearing on the nutritive value of the 'milk' are in progress.

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Bangalore,
July 19, 1945.

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A POSSIBLE USE OF SILKWORM BODY POWDER

Mr. M. J. Narasimhan, Director of Agriculture, Mysore State, kindly supplied a dried powder of apparently uniform quality, obtained after drying the dead bodies of silkworms which are thrown away after the silk is obtained. These silkworm bodies and associated material are at present stacked as refuse, round the villages, where silkworm rearing is a cottage industry or from silk-throwing factories after obtaining the silk, for possible use as manure. An evil smell is produced during the decomposition of this refuse. The powder obtained by drying the silkworm body and grinding, is light brown in colour, fluffy, slightly sticky to the fingers and has a strong characteristic odour not unlike dried meat-powder.

One pound of the powder was extracted with a litre of water at 80° C.; the extract was found to contain about 1·21 grams of total solids per 100 ml.; the broth emulsion so prepared was used, instead of the usual beef-broth, for preparing solid Agar media. No peptone was added. 2·5 per cent. of Agar was used for preparation of Agar slopes and

stands (useful for pour plates); they were transluscent, but deep brown in colour, in spite of using egg-white as a clearing agent. The typhoid bacillus (Rawling's strain), the para-typhoid A & B and vibrio cholera grew rapidly and well on this media ($45 \pm 4{\cdot}5$ millions per square centimetre of surface by 1 ml. of water after 24 hours, at 37° C.); one obtained about the same quantity of growths as becomes available on ordinary Agar slopes prepared with beef-broth, peptone and 2 per cent. Agar, i.e., the routine Agar media used in this Laboratory. Preservation at ice-box temperature (6°C.) for over a week, dries the media so that only a few discrete colonies grow after 24 hours incubation at 37°C.; splitting of the Agar and drying at the tip of the slant occurs. Ordinary Agar media as prepared in this laboratory can, however, be used after 12 days to a fortnight, just as fresh Agar.

Experiments are also in progress for the preparation of peptone (not easily available in the Indian market now—Witte's peptone is not available, and Difco peptone sells at Rs. 65 per lb.) by the use of papain. Preliminary tests are promising.

It is hoped soon to present a more comprehensive study of the use of silkworm powder for bacteriological purposes.

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Bangalore, C. V. NATARAJAN.
May 12, 1945.

POPLITEAL FACET IN SQUATTERS

SOME interest has centred round the variations in the lower end of a femur occasioned by the squatting posture,[1-4] and the present communication is to record yet another variation in the lower end of femora from Punjabis of lower classes, who adopt the squatting posture not only during work but also during rest. In a series of two hundred femora examined, a curved facet, covered with cartilage, was detected in all of them in the posterior part of the lateral aspect of the lateral condyle. It was well marked in some, less so in others, but was present in all. This facet may be looked upon as an extension of the femoral condylar articular cartilage on the lateral aspect posteriorly, just as quadriceps facet[1] is an extension of cartilage anteriorly.

The popliteal muscle arising from the anterior end of the popliteal groove on the lateral side of the lateral femoral condyle, and getting insertion on the upper end of the posterior surface of the tibia, lies in the popliteal groove in the flexion of the knee joint but moves in an arc on the lateral side of the lateral femoral condyl during the movement of extension, till the tendon lies obliquely from before backwards, bevelling the anterior part of its lower border. The friction between the tendon and the side of the condyle is obviated by the synovial membrane acting as a bursa.

As the movements of the knee joint are more frequent in squatting than non-squatting races,[1] popliteal tendon rubs against the lateral condyle much more frequently in the former than in the latter. The popliteal facet owes its existence to this fact.

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Hyderabad (Sind), M. A. SHAH.
May 24, 1945.

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ON THE DEVELOPMENT OF THE FEMALE GAMETOPHYTE IN *HYDROLEA ZEYLANICA* VAHL.

THE single Indian genus, *Hydrolea*, of the Hydrophyllaceæ, is represented by a single species, *Zeylanica*, throughout India abundantly in wet places and rice swamps according to Hooker.[1] The ovule is anatropous and has a single integument. The female archesporium is hypodermal in origin and is usually a single cell but two such cells are noticed side by side oftentimes. It directly functions as a megaspore mother-cell. As a result of the reduction divisions a normal linear tetrad of four megaspores is produced. Only the chalazal megaspore is functional, while the upper three degenerate. The mature embryo-sac is eight-nucleate and normal. The antipodals lie as nuclei and persist till fertilization. Polar fusion takes place before fertilization of the egg but their nucleoli remain separate and distinct for some time in the secondary nucleus. The synergids are comparatively larger in size and they possess big vacuoles at their upper and lower ends. The apices are rounded and not pointed and pyriform as observed by Svensson[2] in *Nemophila* and *Phacelia* of the same family. The egg is much smaller in size and lies at the lower level in the much vacuolated cytoplasm of the sac.

Since the formation of the linear tetrad, the nucellar tissue surrounding it begins to degenerate and they lie as disintegrated cells on all sides and persist till the maturity of the embryo-sac. The cells of the jacket layer which is organised by the innermost layer of the integument, enlarge before the tetrad division of the embryo-sac mother-cell; at the apex near the integument they become rich in cytoplasm and elongated in the radial direction. As soon as the cells of the nucellus are disorganised and absorbed, the fully formed embryo-sac is clearly outlined by this jacket layer.

Dacca Intermediate College,
Dacca, J. N. MITRA.
February 15, 1945.

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THE NATURE OF THE INFERIOR OVARY IN AMARYLLIDACEAE

THE study of transections of flower buds of *Eucharis amazonica* (family *Amaryllidaceæ*) shows that the pedicel possess as a rule an undulating ring of twelve collateral vascular bundles. Six of these are somewhat bigger in size than the alternating six. Of the first six, three again are larger than the alternating three. At the very base of the inferior ovary, the three largest bundles, which are on the same radii as the outer whorl of perianth leaves, divide to form the midrib bundle of an outer tepal, the trace of the superposed stamen and the midrib bundle of one of the carpels on the same radius. The three alternating large bundles, which are on the same radii as the inner whorl of perianth leaves, divide to give rise to the midrib bundle of one of the perianth leaves and the trace of the superposed stamen. The division of the bundles takes place in the same manner as Arber[1] has described in *Hymenocallis*, *Narcissus*, etc. The six smaller bundles of the pedicel divide to form the marginal traces of the adjacent perianth leaves. Thus a transection of the ovary about the middle shows the vascular supply of all the floral whorls quite distinctly marked off from one another even in the wall of the ovary. And, just as Joshi and Pantulu[2] have shown in *Polianthes tuberosa* belonging to the closely related family, Agavaceæ, it is very clear that in *Eucharis amazonica* also the inferior ovary and epigyny have originated as a result of the adnation of the perianth leaves, stamens and carpels.

The author takes this opportunity to express his gratitude to Dr. A. C. Joshi for suggesting the problem and guidance during the progress of the work.

Department of Biology,
Maharaja's College,
Jaipur, S. B. CHATURVEDI.
March 15, 1945.

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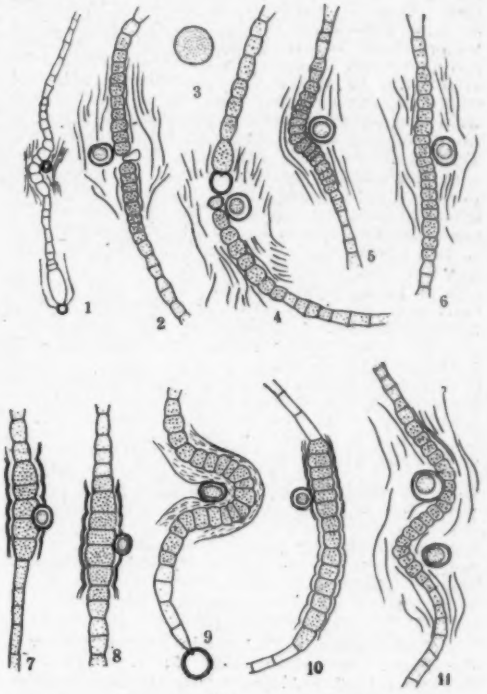
NOTE ON THE REACTIONS OF *GLOEOTRICHIA RACIBORSKII* WOLOSZ., TO A PARASITIC ATTACK

WHILE examining some preserved material of *Gloeotrichia Raciborskii* Wolosz., collected from a lake at Chingleput, the writer came across filaments which were bent in various ways in the middle. A tiny, round, unicellular fungal (?) parasite was found attached to the filament laterally on the inner side of the bent portion (Fig. 1). At first sight this tiny parasite looked like a lateral heterocyst on the filament or a heterocyst of the alga lying loose at the side of the filament, since it showed a certain amount of resemblance to the heterocyst of the alga both in shape and size. A careful examination of the cell, however, showed that it was not a part of the alga, but some foreign organism attached to it. Its contents were more or less homogeneous and colourless and its wall was thin, firm and very finely punctate (Fig. 3). This parasite could not be identified as no other stage of its life-history could be seen in the material.

The chief interest lies in the reaction of the algal filament to the fungal attack. At the region of attachment of the parasite, the cells



FIGS. 1–11. *Gloeotrichia Raciborskii* Wolosz.

Fig. 1. A filament showing the parasite inside the characteristic bend. Fig. 2. A portion of the filament, the cell attacked by the parasite dead and degenerating. Fig. 3. The parasite showing the punctate wall (cell contents not shown). Fig. 4. A portion of the filament with the adjoining cell above the dead cell converted into a heterocyst. Fig. 5. A portion of the filament bent round the parasite. Fig. 6. A portion of the filament just beginning to bend round the parasite.

Figs. 7 and 8. Portions of filaments showing larger and bigger cells with rich contents. Fig. 9. A portion of the filament showing the characteristic bend with the parasite well enclosed in the bend. Fig. 10. A portion of the filament with a number of cells becoming larger. Fig. 11. A portion of the filament with two parasites and two bends.

(Figs. 1–6, 11 from Chingleput lake material and Figs. 7–10 from Elliot's Beach pool material. Fig. 1 × 190, Figs. 2, 4–11 × 333·3 and Fig. 3 × 500).

of the filament increased in contents and became meristematic and soon began to divide repeatedly (Fig. 6). At the same time a dense mucilage was secreted round the filament at this region, and this mucilage later on became brown and lamellated. As a result of this increased growth the algal filament becomes more or less bent round the parasite (Figs. 5, 11). No haustorial connection of any kind between the parasite and the host filament could be made out in the formalin material, but it is reasonable to presume that some kind of haustorial connection probably of a very delicate nature existed in nature and was not preserved in formalin material. The particular cell to which the parasite is attached often degenerates and dies (Fig. 2) and the adjoining cell on the upper side of the filament then becomes converted into a heterocyst (Fig. 4). And the cell next to this heterocyst occasionally develops into a spore. In other words, after the death of the cell attacked by the parasite, the portion of the algal filament above the dead cell behaves like a new filament of *Glœotrichia Raciborskii* with a basal heterocyst of its own.

This parasite was found later on in another collection of *Glœotrichia Raciborskii* from a fresh-water pool near Madras. The alga showed the same reactions to the attack of the parasite (Fig. 7-10).

Instances of *Glœotrichia* being attacked by a parasite do not appear to have been recorded previously. No case of any fungus-attacking *Glœtrichia* is given by Lemmermann (1910), Oudemans (1919) and Seymour (1929).

The author wishes to express his indebtedness to Prof. M. O. P. Iyengar for his kind help and guidance during this investigation.

University Botany Lab.,
Madras, T. V. DESIKACHARY.
May 1, 1945.

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A MOSAIC DISEASE OF CARDAMOM

MOSAIC of cardamom, *Elettaria cardamomum* Maton, also known by the name of *"katte"* or marble disease, is a serious affection of this crop and extends over a wide area. It occurs in Travancore, Mysore and North Kanara, in which latter area it is not only the commonest disease but causes most severe damage to the plants, rendering them commercially useless in a few years after planting.

The first visible symptoms of the disease are manifested by general chlorosis of the entire leaf with slender interrupted stripes of deep-green tissues over its surface. These stripes follow along the veins and run parallel to each other from the mid-rib to the margin of the leaf. When the disease is fully developed, the stripes of green tissue are almost evenly distributed over the leaf, presenting a characteristic mosaic pattern. In nature, cardamom plants are susceptible to infection at all stages of growth.

Affected clumps deteriorate rapidly. The newly formed shoots from such clumps are reduced in size, and there is a gradual reduction in their productivity, followed by death. Many of the clumps wither before they begin to yield.

The disease was first reported by Mollison[1] who considered it a degeneration disease brought about by continuous culture of cardamom under the same conditions of soil and climate, and without any change in methods of propagation and reproduction. Later, Sahasrabuddhe and Bapat,[2] as a result of an investigation into the soils in the cardamom gardens in North Kanara, came to the conclusion that the *katte* disease was induced by an unfavourable soil condition associated with the prevalence of certain types of soil protozoa. Mayne[3] expressed the opinion that the disease was probably of virus origin.

The present experiments on transmission of the *katte* disease were done in insect-proof glasshouses at Sirsi in North Kanara. In some experiments 'sick' soil from diseased gardens or soil into which pieces of rhizomes and roots of affected plants were incorporated, was used to fill pots in which healthy seedlings were transplanted. In another experiment seedlings were directly planted in the garden in pits dug up to remove dead clumps and were carefully protected with muslin cages. In all cases plants under test remained healthy, showing that the disease is not soil-borne.

All attempts to transmit the disease by sap inoculation have so far been unsuccessful.

A survey of the insect fauna of the spice gardens in North Kanara revealed a species of thrips, *Tæniothrips cardamomi* Ayyer, two species of jassids, two species of white flies, and an aphid, probably *Pentalonia nigronervosa* Coq., commonly feeding upon cardamom plants. The aphids breed on the stems underneath loose leaf-sheaths, and large colonies of these insects are found on decaying cardamom plants. The aphids were also found breeding on banana plants.

In transmission experiments with the above insects, only the aphid, *Pentalonia nigronervosa*, readily transmitted the virus of cardamom mosaic. The disease developed in 21 to 46 days after the infective aphids were transferred to healthy plants grown in insect-proof glass-houses.

The above evidence shows that mosaic of cardamom is caused by virus and that it can be transmitted by *P. nigronervosa*, the insect vector of bunchy top disease of bananas. Experiments on transmission of the disease by sap inoculation and by seed are in progress.

Grateful acknowledgment is made of the facilities provided by Mr. Venkatrao V. Nilekani for carrying out experiments in his garden at Sirsi. This work is being carried out under the Plant Virus Research Scheme

financed by the Imperial Council of Agricultural Research.

College of Agriculture, Poona,
April 23, 1945.

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P. M. VERMA.
S. P. CAPOOR.

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THE MOTH *TARAGAMA SIVA* LEFROY, AS A PEST OF GUAVA TREE (*PSIDIUM GUAVA*)

THE caterpillar of *Taragama siva* Lef. (Lasiocampidæ, Lepidoptera) is recorded as a common pest of babul tree (*Acacia arabica*). Lefroy (1909) reports it also to be a pest of rose (*Rosa* sp.) and ber (*Zizyphus jujuba*). The writer finds it to be a pest of the guava tree (*Psidium guava*) at Calcutta.

A small number of caterpillars of this species were noted by the writer at the beginning of July 1944 on a young guava tree of about 9 feet in height. At the end of July 1944 the pests disappeared. In January 1945 the larvæ appeared again on the same tree and persisted till the end of February; as the branches of the tree later were cut down, subsequent history could not be traced. They were leaf-eaters and caused defoliation.

The maximum length of the larvæ was found to be 8·4 cm. The cocoons resembled the colour of the bark of the tree and were usually found in the hollows of the stems or

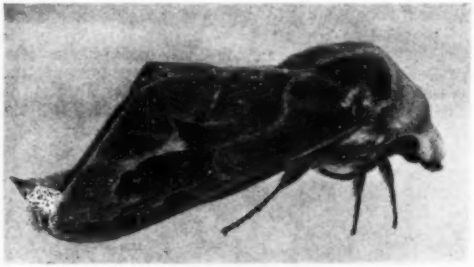

FIG. 1.—The moth *Taragama siva* Lefroy.

near the axils of the branches. The cocoons were tough like packing paper, and were of 4·6 to 5·0 cm. in length. The duration of the pupal period varied from 12 to 20 days.

It is interesting to mention that by the side of the guava tree there were several rose plants, which are said to be infected.

It is also worth noticing that the petal infected the same tree twice consecutively, once in July (summer) and later in January (winter). But the writer did not find the pest on other guava trees of different gardens. It will be interesting to know whether *Taragama siva* Lef. occurs as a pest of guava trees of other localities, and this will determine the question whether its infection is sporadic or not.

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Calcutta,
April 7, 1945.

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A NOTE ON THE PREDATORY HABIT OF *TRIBOLIUM* BEETLES

TRIBOLIUM beetles are observed attacking different cereals, flour and, in general, all stored food products. It is almost a terrible pest attacking the food which is meant for human consumption, and, often the damage is even more serious than that caused by the weevils and other lepidopterus pests. During the course of breeding *Corcyra cephalonica* St. for the mass production of *Trichogramma minutum* at Walchandanagar, it was noticed that the eggs of the moth when inoculated in the culture, did not hatch properly and thus interfered with the multiplication of the moths.

Since these beetles are often found in large numbers in broken *Jowar* which is kept in cages for breeding the moths, their presence is usually ignored. However, their association under the circumstances when hatching was much reduced, created much suspicion and observations under controlled conditions were made. Critical observations on their activities have revealed that these minute beetles are a very serious problem in the culture of *Corcyra cephalonica* and the following observations are recorded in this connection.

Eggs of *Corcyra cephalonica* were introduced in jars in which broken *Jowar* was kept as food. In each of the three experimental jars beetles were also introduced. Every day fresh eggs were counted, mounted on cards and introduced into the jars. Observations were made after 24, 48 and 72 hours when the eggs in the jars were counted. In another jar broken *Jowar* free from *Tribolium* beetles was kept and a definite number of eggs were introduced as a control. The beetles in the jars fed voraciously on the eggs so much so, that only a negligible percentage of eggs were allowed to hatch. During the course of 11 days when the experiments were conducted (Table I) 4,050 eggs were introduced out of which 3,779 eggs, i.e., 93·4 per cent., were eaten up by 84 beetles in the first 24 hours and ultimately only 105 eggs, i.e., 2·4 per cent., were left for hatching. Therefore, enormous damage is caused to eggs which are introduced for the culture in the *Corcyra* breeding cages infested with *Trobilium* beetles. In the

TABLE I

Feeding of *Tribonium* beetles on the eggs of *Corcyra cephalonica* under captivity

Observations	No. of eggs introduced	No. of eggs fed upon			Unfertilised eggs	No. of eggs hatched
		24 Hrs.	48 Hrs.	72 Hrs.		
1	203	179	6	3	12	3
2	305	298	—	—	7	—
3	350	324	19	—	2	5
4	258	239	9	—	1	9
5	180	454	15	—	6	5
6	513	508	4	—	1	—
7	493	418	20	—	3	48
8	510	498	—	—	3	9
9	410	392	—	4	3	15
10	333	318	—	—	4	11
11	195	151	42	—	2	—
Control 185	*No. of eggs unfertilised* 4			*No. of eggs hatched* 181		

control, however, practically all the eggs hatched normally.

CONTROL

Sun-drying or sterilizing the food material at 60° C., are commonly recommended. These precautionary measures hold good only for the infestation already present in the food material. Our observations have revealed that these beetles are not harmful to the larvæ of *Corcyra cephalonica*. Hence it is recommended that besides sun-drying or sterilization, only the larvæ of *Corcyra cephalonica* St. should be introduced into the culture and not the eggs. This will immediately render the beetles harmless even if present in the breeding cages.

College of Agriculture,
Poona,
April 13, 1945.

K. N. TREHAN.
S. A. RAJARAO.

A SPECIAL TECHNIQUE FOR THE IDENTIFICATION OF THE MEMBRACIDAE SPECIES BY THE INTRACELLULAR MICRO-ORGANISMS OF THEIR TUMOURS

SYMBIOTIC micro-organisms of many insects have been studied chiefly by European workers. As *Membracidæ* are rare in Europe, these have not been investigated thoroughly. It is proposed to present in this note the results of a few common species, with regard to the intra-cellular microorganisms found in the tumours.

The tumours are present in the abdomen of all the individuals at the two sides in the fatty-tissue of the insect. They are trilobed and can be separated very easily from the fatty-tissue under a binocular microscope. They look like glands, but naturally no ducts or outlets are present. In many cases they are pigmented—in *Oxyraches tarandus* Fabr., they are light pink, in *Leptocentrus lucaspis* Walk., yellow, in *Telingana caneacens* Buckt., pale yellow. If a smear of the tumour is made on a clean slide and stained according to the method given below, the micro-organisms are seen clearly within the cell and scattered outside also.

Smear of the tumour is made on a slide and while still moist the slide is flooded with Bouin's fluid. After treatment for 40 minutes with the fixative the slide is washed with 50 per cent. and 70 per cent. alcohols and later rinsed well in tap-water. It is then stained with Giemsa solution prepared by adding 1 c.c. of the stock solution to every 25 c.c. of the buffer, and stained for an hour. It is then washed with tap-water and subsequently treated for a few minutes with buffer and dried. When well-stained the smear presents a beautiful polychrome effect: the nuclei and microorganisms are of varying shades of pink and red, the ground cytoplasm blue and other cytoplasmic inclusions of mixed hues.

In Hyderabad proper there are about seven to eight species of the family Membracidæ which are easily available. They are found on *Acacia arabica* (Bhabul), *Psidium guava* (Guava tree), and *Zizyphus jujuba* (ber plant), and many other plants of economic importance. Some of the species like *Oxyraches tarandus* Fabr., *Otinotus oneratus* Walk., at the very sight give an impression that they are different species. But there are many other species which look alike, *e.g.*, *Tricentrus assamensis*, and *Tricentrus selenus* Buckt. In the nymphal stages it is still more difficult to differentiate one nymph from the other, although some do show a difference. But when the intra-cellular micro-organisms of the different species of *Membracidæ* are examined we get to the following picture. In *Oxyraches tarandus* Fabr., the micro-organisms are short and rod-like in form, and are found within the cell. Small granule-like bodies are also present in large numbers, and some of the granules assume beaded form as shown in Fig. 1. In *Leptocentrus lucaspis* Walk., the

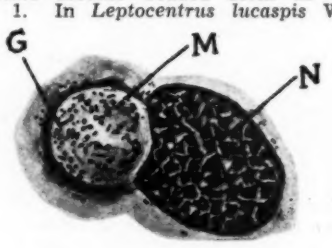

FIG. 1. *Oxyraches tarandus* Fabr.

micro-organisms are arranged in a circular manner within the cell in large numbers. The micro-organisms are more or less dumb-bell-shaped and they are generally present in pairs as shown in Fig. 2. In *Tricentrus assamensis* the micro-organisms are of very peculiar shape. They are long, threadlike and very often the threads are broken into small pieces as shown in Fig. 3. In *Leptocentrus longi-*

spinus Walk., the micro-organisms are spherical in form and look like yeasts. These are found in batches and also singly as shown in Fig. 4.

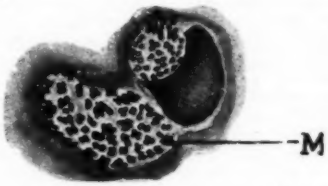

FIG. 2. *Leptocentrus lucaspis* Walk.

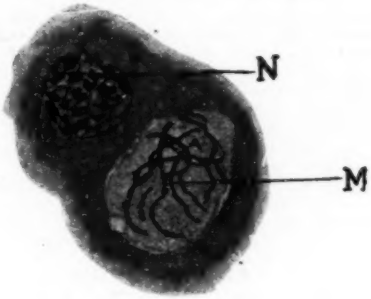

FIG. 3. *Tricentrus assamensis*

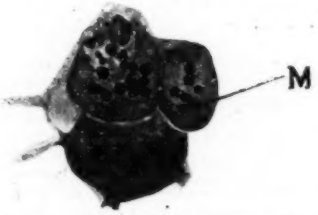

FIG. 4. *Leptocentrus longispinus* Walk.
(Magnified to 1000)
G—Granules. M—Micro-organism. N—Nucleus.

In some species like *Telingana canescens* Buckt., and *Tricentrus selenus* Buckt., the micro-organisms are not to be seen in the tumours when a smear is made and stained with Giemsa's stain. The above-mentioned variation is still under investigation and has to be confirmed.

In conclusion, it may be said that the examination of symbiotic micro-organisms whenever present greatly helps the identification of the species.

I am much thankful to Dr. S. Mahdihassan for his suggestions and active interest, and to Dr. B. K. Das, Chairman, Zoology Department, Osmania University, for his kind encouragement.

Hyderabad, MOHAN BABU NAIDU.
May 31, 1945.

A PRELIMINARY NOTE ON THE PLANKTON OF BOMBAY HARBOUR

THE plankton from Bombay and adjoining waters has not been regularly studied in the past and no published account of its composition, seasonal abundance and variation is available, except for a few notes on the systematics of such groups as Hydromedusæ[1] and Sagittæ[2]. We have, therefore, undertaken a systematic study of our local plankton with a view to collect such information as will, when accumulated, be of great practical help in the expansion of our fisheries on scientific lines. The present note is a result of our observations made during the past few years, particularly from June 1944. Plankton collections are made twice a week. Two hauls, each of fifteen minutes' duration, are taken each time. Moreover, a weekly record of chemical analysis of sea-water collected from the same site, together with the meteorological data is maintained to enable us to correlate at a later date the fluctuations in the planktonic population with the physical and chemical conditions of the sea.

The salient features of our plankton are the following:—

(1) The Hydromedusæ, Siphonophores, Ctenophores, Sagittæ and Copepods are some of the commonest members of our plankton obtained almost all the year round. The siphonophores and ctenophores are found in large numbers from November to March. The copepods have two periods of maxima, one in July and the other in January.

(2) Most of the Decapod larvæ make their appearance towards the end of rainy season and are found in majority of the subsequent catches till the end of March.

(3) The Tunicates appear by the middle of October and reach their maximum in January and February.

(4) The number of fish-eggs in our samples is lesser than those collected in European waters over the same period. Fish-larvæ and post-larvæ of some fishes occur over a number of months, thereby indicating a prolonged breeding season.

(5) The Diatoms and the Dinoflagellates which constitute the bulk of the phytoplankton are found in abundance during the cold months of the year, particularly January and February.

The following is the summary of the occurrence and seasonal variations of some of the important groups of planktonic organisms. *Protozoa* (Infusorians, Dinoflagellates, Foraminifera and Heliozoa):—

Members of each of these groups occur in our collection almost throughout the year.

Cœlenterates:

Hydromedusæ form one of the major groups which, in our collection, include both littoral and oceanic forms carried in by the currents of water. Some of the commonest species are *Steenstrupia bigelowi*

(Mass.), *Phortis ceylonensis* (Browne), *Phialucium virens* (Bigelow), *Agiaura hemstoma* (Perorn et Lesueur), *Lirope tetraphylla* (Chamissao et Eysenhardt) and *Solmundella bitentaculata* (Quoy et Gaimard).

Siphonophores: These include species of Monophyes and Diphyes and a few colonies of Physonecti, the latter occurring in August, September, January and February.

Ctenophores: They consist of Pleurobranchia and Berœ, occurring in fairly large numbers from September to the end of March. The largest specimen of Berœ found in our samples was 2" × 1".

Polychæta:

Planktonic forms of Nereida occur at intervals all the year round but are very common from September to May. Tomopteris is fairly constant in our catch from September to March.

Chætognatha:

The three commonest species of Sagittæ are *S. gardineri* (Doncaster), *S. bedoti* (Beraneck), *S. Bombayensis* (Lele et Gae) and they appear in varying numbers almost throughout the year.

Copepods:

A general survey of Copepods from month to month shows that their peak periods of occurrence are in the months of July and January suggesting thereby two cycles of maxima. They are found in fairly large numbers at the beginning of monsoon and reach their maximum by the end of July, after which the number falls to its minimum by August. From September onwards their population gradually increases again until it reaches its maximum by January of the next year. Some of the commonest species are: *Acrocalanus monachus* (Giesbrecht), *Eucalanus suborassus* (Giesbrecht), *Paracalanus parvus* (Giesbrecht), *Acartia spinicauda* (Giesbrecht), *Centropagesdorsispinatus* (Thompson et Scott), *Centropages typicus* (Kroyer) and *Euchæta marina* (Giesbrecht).

Decapod larvæ:

Copepod naupli are found throughout the year.

Stomatopod larvæ (mostly Alima) are present from August to May and in large numbers in November.

Zœa of Porcellana occur from November to March with swarms at intervals in December.

Zœa of Brachyura is collected from August to April in varying numbers.

Megalopa is taken in small numbers all the year round.

Phyllosoma of Panulirus is present from December to April, largest number being in January.

Larvæ of Prawns are obtained from May to January inclusive. Their number is predominantly large first in the months of July and August, and again in November and December.

Tunicates:

Doliolum and Salpa are the chief forms representing this group in our samples and occur from the middle of October to the end of February. In January and February they appear in very large numbers, at times in swarms. They occurred in unusually large quantity once in October 1942.

Our biological year beginning with the onset of monsoon can be roughly divided into the following four periods according to the variations in the catch. During the rainy season, i.e., June-September, our plankton samples are rather poor both in quality and quantity; but after the rains, *viz.*, from October to December there is an appreciable increase in the catch as more and more transitional planktonic organisms like Decapod larvæ, occur in fluctuating numbers. January, February and part of March seem to be the most favourable months of the year for the occurrence of plankton as swarms of a number of groups of organisms appear at frequent intervals. But during April and May there is a considerable fall in the number of the transitional as well as permanent members of the plankton with the result that the samples taken towards the end of May appear to be meagre.

Department of Zoology,
Royal Institute of Science,
Bombay,
May 29, 1945.

D. V. Bal.
L. B. Pradhan.

1. Lele, S. H., and Miss Gae, P. B., *J. Bom. Uni.* 1935, **3**, Pt. 5. 2. —, —, *Ibid.*, 1936, **4**, Pt. 5.

SOME IMPORTANT FEATURES OF THE LIFE-HISTORY OF *STENOBRACON DEESAE*—A BRACONID PARASITE OF THE SUGARCANE AND JUAR BORERS OF NORTHERN INDIA

Steno-bracon deesæ is abundantly found in sugarcane and juar fields from May to November in the Aligarh District. It is scarcely seen during the remaining part of the year. The male parasites are less active than the females and the percentage of emergence of the former is greater than that of the latter.

The female actively moves on the surface of stems in search of borers. On reaching the exact spot it introduces its long ovipositor into the tunnel, excavated by the borer, and parasitizes it. The egg-laying process is always preceded by the stinging of the host.

The egg-laying process normally does not require more than two minutes. The parasite generally lays only one egg on or close to the body of every host. Under compulsion even nine eggs may be laid in one tunnel within twelve hours. The parasite refuses to deposit eggs on exposed or dead hosts or hosts which have already been stung by another parasite.

Hatching takes place in twenty-three to twenty-six hours at temperatures between 70° F. and 104° F. maximum, the presence of light being necessary. Hatching has taken

place even after the expiry of the normal time for incubation when higher humidity was provided.

The larva undergoes four moults. Each stadium is of twenty-four hours' duration. After fourth ecdysis, cocoon formation starts which requires twenty-four hours for completion. Generally fourth ecdysis and the exhaustion of the host synchronize.

The larva though inside the cocoon is still active and retains larval form till the beginning of the sixth day after fourth ecdysis. At the end of the sixth day it becomes inactive, passes out fæcal matter of brownish colour enveloped within its peritrophic membrane (dejectamenta) and acquires the shape of prepupa. At the termination of the seventh day it casts off the last, i.e., the fifth larval skin. This ecdysis always takes place inside the cocoon. The prepupal stage is of twenty-four hours' duration and ends with the expiry of the seventh day. The prepupa remains enclosed within the last larval skin whose casting off coincides with the process of transformation of prepupa into pupa. The period between fourth moult and the emergence of adults is of seventeen to twenty-one days' duration. The pupa at the time of emergence leaves behind fragments of the cast skin. The total number of days required from the time of egg-laying to the emergence varies from twenty-two to twenty-six days.

During winter, the duration from egg-laying to emergence ranges between forty-six to fifty-eight days at field temperature. In this season the hatching period and the duration of every stage is almost doubled. This aspect of long and short-timed generations has not hitherto been noted in the life-history of either this or its sister species, namely, *S. necevillei*.

It has been observed that the larvæ of the parasite in the stored stems of juar take longer time to emerge than those in the field during winter months. Such cases of delayed emergence in the stores and godowns have been recorded at the end of the following month of March. It may be concluded that the storing is helpful for the repetition of life-cycle of the parasite at the end of winter season every year.

The phenomenon of parthenogenesis is very common during winter and less common in the remaining part of the year.

It has been recorded that the maximum percentage of successful hatching is about 70; while that of emergence of adults from cocoon is above 90; The maximum number of eggs laid by a single female is thirty-two. If a female is forced to lay more than one egg on or near the same host then only one egg is hatched; but on distributing these eggs on separate hosts about 50 per cent. of eggs have been observed to hatch.

The maximum longevity of a parasite both male and female after emergence from the cocoon is fifty-one days. The average longevity of the male is thirty-seven days. This age limit falls down during summer months. The females invariably die soon after they have finished egg-laying. This parasite is very sensitive to unhygienic conditions, hence every care should be taken while breeding it in order to provide healthy environment to achieve good results.

A detailed description of biology, life-history, and morphology of the parasite will shortly be published elsewhere.

The writer is highly indebted to Dr. M. A. H. Qadri for the most valuable and indispensable help and guidance he has received from him while working on this problem. He is also thankful to Prof. M. B. Mirza for permission to use his well-equipped laboratory and for financial assistance.

Department of Entomology,
Muslim University,
Aligarh, SHAH MASHHOOD ALAM.
May 15, 1945.

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THE I. C. I. RESEARCH FELLOWSHIPS AND THE DELEGATION OF INDIAN SCIENTISTS

AT a luncheon held in honour of the Delegation of Indian Scientists, Lord McGowan, Chairman, Imperial Chemical Industries, reported that the Directors of the Company had offered to provide at nine Universities in Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in various branches of science. He revealed that by way of Excess Profits Tax, National Defence Contribution and Income-tax, the Company paid to the British and Overseas Governments a sum amounting to 12·5 million sterling.

Replying to the toast proposed by Lord McGowan, Sir Shanti Swarup Bhatnagar referred to "The I.C.I.'s partiality to their own country". He pointed out that the Imperial Chemical Industries had two big and prosperous factories in India and pleaded "for grants on a generous scale for scholarships for scientific research in India by the I.C.I." This suggestion appears to have immediately caught the imagination of Lord McGowan. While agreeing to consider in a friendly way the question of endowing research fellowships in Indian Universities, Lord McGowan assured the members of the Indian Delegation, that the eighty fellowships in the British Universities would be open to Indian scientists in free competition.

This in short is the "inside story" of the I.C.I.'s farsighted and enlightened munificence now extended to the Universities in India. Details of this Fellowship Scheme are published elsewhere in this issue.

REVIEWS

Synthetic Rubber from Alcohol. By A. Talalay and M. Magat. (Interscience Publishers, Inc., New York, U.S.A.), 1945. Pp. 298. Price $5.00.

This book is a publication on a subject of topical interest. The Russian Planners with great foresight encouraged and financed investigations by their scientists on the production of synthetic rubber from alcohol in anticipation of a war which might cut them off from the sources of natural rubber. The book is a story which tells us how the Russian scientists rose to the occasion. Not only were synthetic rubber plants functioning successfully in Russia when Germany declared war against her; but she was able to render material assistance to U.S.A. when Japan got possession of the natural rubber resources of the East Indies. The authors have rendered a service to the English-speaking scientific world by presenting in a book form the valuable work which had remained inaccessible in Russian literature.

This technical process centres round the well-known discovery of Lebedov that a combination of a dehydrating and dehydrogenating catalyst can give butadiene, in considerable yield, from alcohol. The catalyst and technology have been continuously improved with the result that the yield of butadiene increased from 22 per cent. in 1934 to 41 per cent. (or 70 per cent. of theoretical) in December 1939. Unfortunately the method of preparation of the catalyst has not been revealed; and one has got to remain content with the observation that it is a combination of two materials A and B which may be zinc oxide or aluminium oxide or manganese oxide, etc. The technology of the process, however, has been described in considerable detail. The Emulsion method of polymerising butadiene into synthetic rubber is practised in Germany and other countries but not in Russia; and here valuable information has been given as to how emulsion polymerisation should be done. In Russia, the polymerisation or rather to be accurate, polycondensation of butadiene into rubber is carried out, with the aid of a finely dispersed sodium catalyst "mostly spread thinly over metal shelves or trays".

Besides this Russian work, the book gives general information on the physico-chemical properties of butadiene polymers, *e.g.*, their chemical constitution and molecular weights, X-ray structure and mechanical properties, plasticity, gel formation, oxidation, heat-hardening, viscosity, etc. The treatment of the subject is well balanced—theory and practice —each receiving due share of attention.

It is not surprising that some vital information relating to the production of synthetic rubber from alcohol should have been withheld in war-time for reasons of security, but it is surprising to note that Russian scientists take out patents not only in countries outside Russia but also in their own.

J. C. G.

An Outline of Industrial Metallurgy. By D. G. P. Paterson and J. Bearn. (Chapman and Hall, Ltd., London, W.C. 2), 1944. Pp. 185. Price 12*sh.* 6*d.*

A publication of this kind is of great assistance to non-specialists interested in the manufacture of metals, and also to a Research worker on the latest developments of iron and steel and other important non-ferrous metals. It deals with all aspects of metal working commencing from the smelting of the ore down to the final finishing of all products. Perhaps, another chapter describing details of smelting of iron, steel and more prominent of non-ferrous alloys would have added to the value of the book. When it is remembered that the various processes involved in different stages are exceedingly complicated, the reader will appreciate the procedure adopted by the authors, helping him to have a clear understanding of the subjects.

As metal working requires the use of high temperatures, the importance given to the scientific measurement of temperatures is correctly emphasized. The principal features of smelting and shaping of the metals and alloys are very clearly, though briefly, dealt with. The physical and chemical properties attained by the metals as a result of various treatments are discussed in great detail and should prove immensely useful to all research students and non-technical readers. Methods of thorough examination of the metals and alloys under microscope and X-ray, have been described clearly and the Research worker finds ample hints and notes on the procedure to be followed. Interpretation of the results so achieved, and means of locating and determining the extent of defects in the metallic materials are exhaustively treated.

In these days when the metals are required to satisfy very rigid specifications, and to prove their worth for complete freedom from risk and uncertainty, chapters dealing with this aspect will undoubtedly prove very valuable.

During the last twenty years and especially during the war years, the great importance emphasised on the heat treatment of the metals and alloys is brought out very clearly, and details of different methods of heat treatment for certain types of alloys are set forth. Chapter on Industrial Heat treatment and the subsequent chapters describing among others, latest methods of normalising, bright annealing by cracked ammonia process, hardening and tempering of special alloy steels, nitriding, etc., contain valuable information useful to all engaged on the manufacture of alloy steels.

Till recently one of the chief drawbacks in the larger use of some of these highly specialised alloys was the difficulty in handling them and machining them. These difficulties are being overcome by giving them a special treatment prior to machining, and by the use of special cutting tools—a development of far-reaching importance to Engineering Industries.

Special detailed treatment of aluminium alloys and stainless steels dealt with in two chapters indicates the importance these alloys are playing in the modern-day high class engineering practice. Means of improving the qualities of metals, normally possessing ordinary qualities, have also been dealt with.

The question of repairs to the broken or damaged parts of metals has not escaped the attention of the authors. The different practices such as soldering, gas welding, electric welding have been treated in a very clear manner. Improvement in the technique of electric welding and the development of induction and other means of hardening of parts liable to wear have been clearly described.

Finally, the action of various agents in corroding, thereby shortening the lives of metals is referred to. Some methods of protecting them against corrosion may be traced back to the days when metal began to be used. Remedies have been suggested and adopted from time to time and many of them have limitations. The urge for utilising all the natural resources in the world to the best advantage and the anxiety that the metallic resources will soon get depleted if the present increased rate of consumption continues have led to intensive research on methods of preventing corrosion, and this aspect has been very exhaustively dealt with and the various protecting agents and methods of applying them are described in detail.

Numerous illustrations, diagrams, microphotographs, etc., greatly enhance the usefulness of this publilcation.

D. V. KRISHNA RAO.

You and Your Radio. By Vepa V. Lakshmana Rao. (Addison & Co., Ltd., Madras), 1945. Second Edition (Revised). Pp. 170. Price Rs. 5.

A book for the relatively non-serious students of Radio, who do not care to delve very deep but wish to be entertained and lightly instructed while operating their Receiving sets, has long been needed. *You and Your Radio* by Vepa V. Lakshmana Rao which covers the entire story, fills a distinct want in this direction.

The author has divided the book into twenty-three chapters. Beginning with fundamental lessons and carrying through the Broadcast chain, he follows it up with simple and easily understood explanations of the Radio receiver and its allies. Besides discussions and pictures illustrating points of technique, the book includes a number of art plates covering various aspects of Broadcasting.

The excellent reception accorded the first edition of this book since its appearance in 1942 has prompted the author to undertake this revised edition.

Though largely devoted to the interests of the general reader, this book will provide much useful information to the Radio technician.

C. R. K.

The Rubber Industry in India. By Dr. N. N. Godbole. A.I.M.O. Monograph No. 6. (All-India Manufacturers' Organisation, Bombay). Pp. 24.

This is a cursorily written pamphlet of but 24 pages (4″× 6″) of which five are devoted to History, six to Chemistry, four to Latex, and the rest to Rubber Trade and Technology. There is not enough of useful information in any of the sections, excepting perhaps to some extent in the last, and the general usefulness of this pamphlet in this well-known series is very doubtful.

Sargentia—No. V. *Fragmenta papuana* (observations of a naturalist in Netherlands New Guinea). By H. J. Lam. Pp. 1-196, with two maps and thirty-two text-figures. Translated from the Dutch by Lily M. Perry. (Published by the Arnold Arnold Arboretum of Harvard University, Jamaica Plain, Mass., U.S.A.), 1945. Price $ 3.00.

This publication of the Arnold Arboretum, being a translation into English of Professor Lam's original Dutch work, has come to be under the stress of war. To-day information is sought for, as never before, regarding poorly known flora of several parts of the globe. Dr. Lily M. Perry's efforts with inspiration from Dr. Frans Verdoorn is, therefore, amply rewarded by the wealth of information she has presented in the volume both topographical and botanical. Dr. Perry's appreciation of Prof. Lam's presentation of botanical enumerations and descriptions and his faithful recording of detail is fully justified by this excellent publication. It would be impracticable to dwell, within the space of this review, on the various botanical details presented therein. Nevertheless, the statistics of the collection given as below may convey an idea of the richness of the flora of the Netherlands New Guinea.

The entire collection of Professor Lam has been placed in 109 plant families. Of the 109 families studied, 467 members represent 285 species, of which 103 are new. In the Pteridophytes the 344 members belong to 204 species, of which 66 are new.

In addition to the description of these plant material the author has very ably presented minute details of the Ecology of the terrain and the occurrence of respiratory roots and pneumatophores in mangrove rattan—hitherto undescribed; of fragrant flowered *Barringtonia* sp.; of other trees with enormous prop-roots, etc. There are excellent sketches of landscape, other drawings of plant material and a good deal of information on Myrmecophilous plants which make reading very pleasant. Publications of this description should find a place in college libraries, for it stimulates thinking in the undergraduate botanist on the modes of describing floras of localities in a country like ours where great patches of vegetation are still largely a *terra incognita* from the botanical point of view.

T. S. SADASIVAN.

SCIENCE NOTES AND NEWS

Messrs Hargolal & Sons, The Science Apparatus Workshop, Ambala Cantt., seek to make contacts with inventors and others who may have ideas relating to designing, improvements or introduction of new scientific instruments and allied products. Main objective is the marketing of improved products or new ideas for instruments for educational science. Ideas may also relate to scientific toys and games. All ideas submitted will be treated with utmost confidence and will be exclusive property of the inventors unless it is adopted by the firm. Further particulars from: Managing Proprietor, Hargolal & Sons, Ambala Cantt.

MAGNETIC NOTES

Magnetic conditions during June 1945 were slightly less disturbed than in the previous month. There were 22 *quiet* days, 7 days of *slight* disturbance and 1 day of *moderate* disturbance as against 20 quiet days and 10 days of slight disturbance during the same month last year.

The quietest day during the month was the 29th and the day of the largest disturbance the 6th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
1–5, 11–16, 18–26, 28, 29.	7–10, 17, 27, 30.	6

No magnetic storms occurred during the months of June 1944 and 1945.

The mean magnetic character figure for the month of June 1945 was 0·30 as against 0·33 for June 1944.

A. S. CHAUBAL.

Magnetic conditions during July 1945 were more disturbed than in the previous month. There were 18 *quiet* days and 13 days of *slight* disturbance as against 27 quiet days and 4 days of slight disturbance during the same month last year.

The quietest day during the month was the 27th and the day of the largest disturbance the 17th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days
	Slight
2, 9–15, 19–22, 24–27, 29, 31.	1, 3–8, 16–18, 23, 28, 30.

No magnetic storms occurred during the months of July in 1944 and 1945.

The mean character figure for the month of July 1945 was 0·42 as against 0·13 for July 1944.

M. PANDURANGA RAO.

It is proposed to hold the 14th Conference of the Indian Mathematical Society at Delhi during the third week of December, 1945. Authors of papers are requested to send their papers with abstracts to Dr. A. Narasinga Rao, Annamalai Nagar, before the end of October, 1945.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the Seismographs in the Bombay (Colaba) Observatory, there were two moderate and one slight shock during each of the months June and July 1945. Particulars of these shocks have been given in the table below.

1945 Month and Date	Time of origin I.S.T.	Intensity of shock	Epicentral distance from Bombay	Co-ordinates of epicentre	Remarks
	H. M.		(Miles)		
June 4	18 39	Moderate	815	Lat. 29° N.; Long. 81° E.	Felt in Delhi and other places in Northern India
14	06 14	Slight	1725		
23	00 30	Moderate	1300		
July 15	12 05	Slight	4680		
22	17 10	Moderate	2035		
23	10 25	Moderate	1815	Lat. 39° N., Long. 53° E. Near Caspian Sea.	

913-48 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for The Current Science Association, Bangalore